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ENGINEER DESIGN TEST OF 5.56-MM HECKLER AND KOCH MACHINE GUN, MODEL 23A1

FINAL LETTER REPORT

BY

FRANKLIN H. MILLER

DECEMBER 1974

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The test and evaluation of a 5.56-mm HK-23A1 machine gun was conducted at US Army Aberdeen Proving Ground, Maryland, from 18 February to 30 September 1974 for the purpose of determining the physical and technical characteristics of the weapon and ammunition. A total of 2400 rounds was fired. The weapon was subjected to an initial inspection and safety investigation, an accuracy and dispersion test at 100- and 300-meter ranges, an endurance test, and maintenance and human factors evaluations. The evaluations were terminated prior to completion of the endurance test due to the

20. frequent occurrence of feeding failures, and for safety reasons. Firing of the weapon produced severe case-head swelling and ejection of the primer from the case. The testing of the weapon in a high- and low-temperature environment, originally scheduled after the endurance test, also was cancelled. The cause of the weapon-related malfunctions and cartridge-case casualties was not determined prior to test termination.

DEPARTMENT OF THE ARMY
US ARMY ABERDEEN PROVING GROUND F. H. Miller/rlb/870-3711
ABERDEEN PROVING GROUND, MARYLAND 21005

STEAP-MT-I 8 JAN 1975

SUBJECT: Final Letter Report of Engineer Design Test of 5.56-mm Heckler and Koch Machine Gun, Model 23A1, TECOM Project No. 8-WE-400-SAW-003, Report No. APG-MT-4547

Commander
US Army Armament Command
Rock Island, Illinois 60201
ATTN: AMSAR-RDG

1. REFERENCES

a. Letter, AMXAA-WS, 25 October 1972, subject: Request for Test Plan and Time/Cost Estimates - Squad Automatic Weapon (SAW) Preliminary Engineer Design Test (EDT).

b. Letter, AMSTE-BC, TECOM, 9 November 1972, subject: Customer Test Directive for Developmental Test of Squad Automatic Weapon (SAW), TECOM Project No. 8-WE-400-SAW-003.

c. Letter, AMSTE-IN, TECOM, 14 August 1974, subject: Engineer Design Test of Foreign 5.56-MM Light Machine Guns Fabrique Nationale and Heckler & Koch, TECOM Project No. 8-WE-400-SAW-003.

2. BACKGROUND

a. The authority for conduct of this test is given in reference b.

b. The US Army Small Arms Systems Agency (now assimilated into the US Army Armament Command) requested that foreign 5.56-mm machine-gun designs be tested to determine their potential as military weapons. One weapon was procured for this evaluation at Aberdeen Proving Ground, Maryland.

c. The 5.56-mm machine gun Model HK-23A1, manufactured by Heckler and Koch of West Germany, is a lightweight, roller-locked (delayed blowback), air-cooled, belt- or magazine-fed weapon. The selective fire mechanism allows delivery of fire in the semiautomatic, fully automatic, and 5-round controlled-burst modes. This weapon is capable of being fired from offensive (i.e., shoulder and hip) and defensive (i.e., bipod and tripod) positions using a 200-round-capacity ammunition container attached to the bottom of the feeder mechanism. The weapon features a quick-change, fixed-headspace barrel. The ammunition is assembled in disintegrating metallic link belts (push-through type). The standard 5.56- by 45-mm cartridge case is used and assembled with heavy ball or tracer projectiles (the ball round is designated XM 287 and the tracer round is designated XM 288). The rifling rate of twist is one turn in 222 mm. Other types of 5.56-mm ammunition may be used by replacing the barrel with one of the correct rifling rate of twist and by exchanging the locking piece with one exhibiting the correct locking angle.

d. The purpose of this test was to determine the physical and technical characteristics of the test materiel. The testing consisted of an initial inspection and safety evaluation, an accuracy and dispersion evaluation, and function performance firing (endurance) at normal ambient range temperature.

e. Originally, the squad automatic weapon (SAW) program was to evaluate both 5.56- and 6.00-mm weapon systems. Subsequently, all 5.56-mm systems were deleted from this evaluation, including the HK-23A1 machine gun, and were directed to be tested and reported for informational purposes only as an engineer design test. Although the singular weapon sample does not generally constitute a statistically adequate sample size, the objectives of this test were met. The testing was conducted from 18 February to 30 September 1974.

3. OBJECTIVE

The over-all objective of this test was to evaluate the design and operating characteristics of the machine gun.

4. SUMMARY OF RESULTS

A total of 2400 rounds was fired. The resultant mean rounds between failures was 14 and the malfunction rate for each 1000 rounds fired was 72 for chargeable malfunctions. The maintenance man-hours for each round fired was 31.25×10^{-4}. A total of seven component parts were broken during the test; these required replacement. The failures all resulted in the creation of weapon stoppages.

STEAP-MT-I

SUBJECT: Final Letter Report of Engineer Design Test of 5.56-mm Heckler and Koch Machine Gun, Model 23A1, TECOM Project No. 8-WE-400-SAW-003, Report No. APG-MT-4547

There were no ammunition deficiencies or shortcomings. A total of two deficiencies was charged against the weapon: A high frequency of feeding failures and the creation of severely swollen cartridge-case heads and blown primers as a result of firing. This latter deficiency was also classified as a category III (critical) safety hazard (potential) in accordance with MIL-STD-882. The component part failures were classified as shortcomings.

The human-factors aspects of the weapon design were demonstrated to be satisfactory with regards to weapon controllability during automatic burst fire from the prone, bipod-supported position. The weapon could be readily maintained if disassembly and reassembly was limited to the operator level (modular components). The recurrent failure to properly assemble the firing mechanism to the receiver assembly caused permanent damage to the catch/release lever, which rendered the weapon inoperable until that part was replaced. Although this problem is primarily one of personnel error, it is caused by faulty weapon design, which permits this condition to occur.

Testing was terminated prior to completion of endurance firing due to the potential safety hazard.

FOR THE COMMANDER:

Billy D. Sissom

1 Incl
Details of Test

BILLY D. SISSOM
Associate Director
Materiel Testing Directorate

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DETAILS OF TEST

1.1 INTRODUCTION

The testing described herein was not evaluated against specific test criteria because none were provided. The analyses that are made are therefore general in nature and are directed toward achieving generally acceptable levels of weapon and ammunition performance as they pertain to machine guns used for military applications.

Figure 1.1-1 shows the right and left side views of the HK-23A1 machine gun.

Figure 1.1-1: The 5.56-MM HK-23A1 Machine Gun, Adapted for Belt Feed. Right (TOP) and Left Sides.

1.2 INITIAL INSPECTION AND SAFETY EVALUATION

1.2.1 Method

The weapon and ammunition were subjected to detailed inspections to determine their respective characteristics. The ammunition was disassembled and the component parts were weighed and measured. Another sample of ammunition was evaluated for velocity, pressure and action time, using standard ammunition test procedures (Reference AMSMU-P 715-501FA1). The barrels provided by Frankford Arsenal for obtaining velocity and pressure data had one turn in 9 inches as the rate-of-rifling twist.

The weapon was visually inspected for defects in manufacture. The component parts were subjected to a magnetic-particle inspection to detect any incipient defects not observed during the visual inspection. Next, the weapon was weighed and measured. Time trials were recorded for barrel change, magazine change and loading, and weapon disassembly and reassembly. Reverse or incorrect assembly of components and its effect on safety and weapon operation was assessed. Double-feed safety and function firing checks were made to determine safe handling requirements.

1.2.2 Results

The HK-23A1 machine gun was received at APG in damaged condition. The packaging container (which contained the assembled weapon, eight spare barrels, and assorted spare parts and ancillary equipment in loose array) did not protect the materiel adequately during transit, and was itself heavily damaged, as shown in Figure 1.2-1. The buttstock was broken at the wrist (Figure 1.2-2). A radiograph of the spare (unbroken) buttstock was made and is shown in Figure 1.2-3.

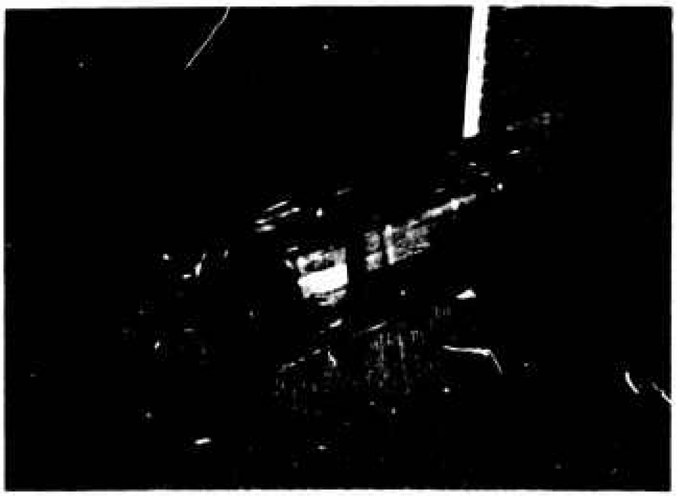


Figure 1.2-1: Condition of the Packing Container for the 5.56-MM HK-23A1 Machine Gun as Received at APG.

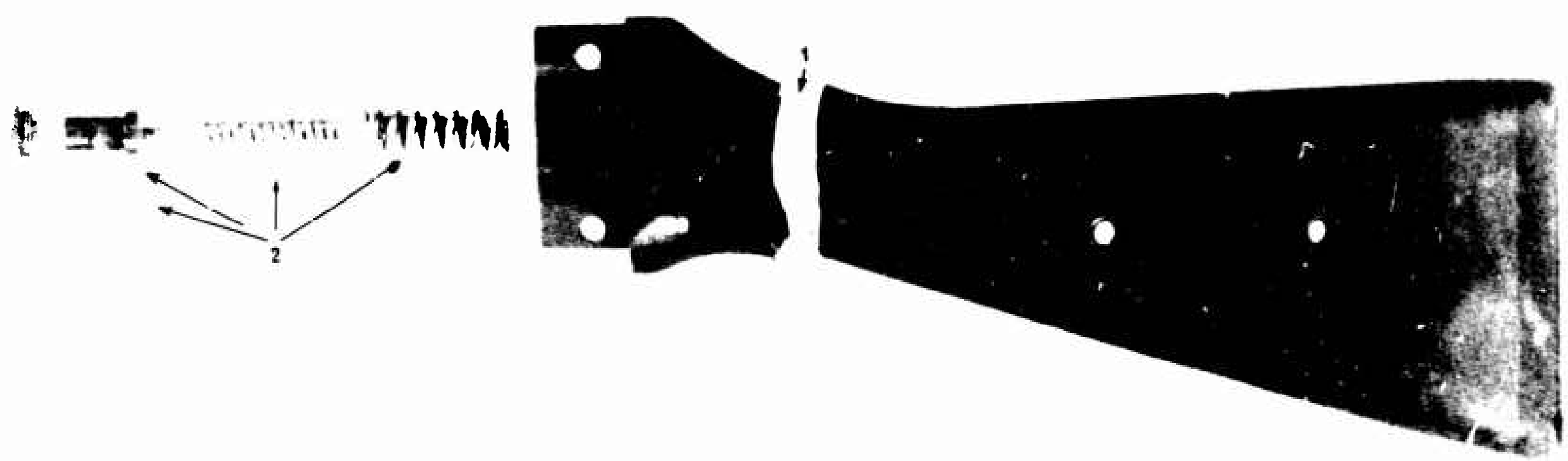


Figure 1.2-2: Broken Buttstock (Arrow No. 1) as Received for Test. Buffer Components (Arrow No. 2) were Disassembled for Illustration.

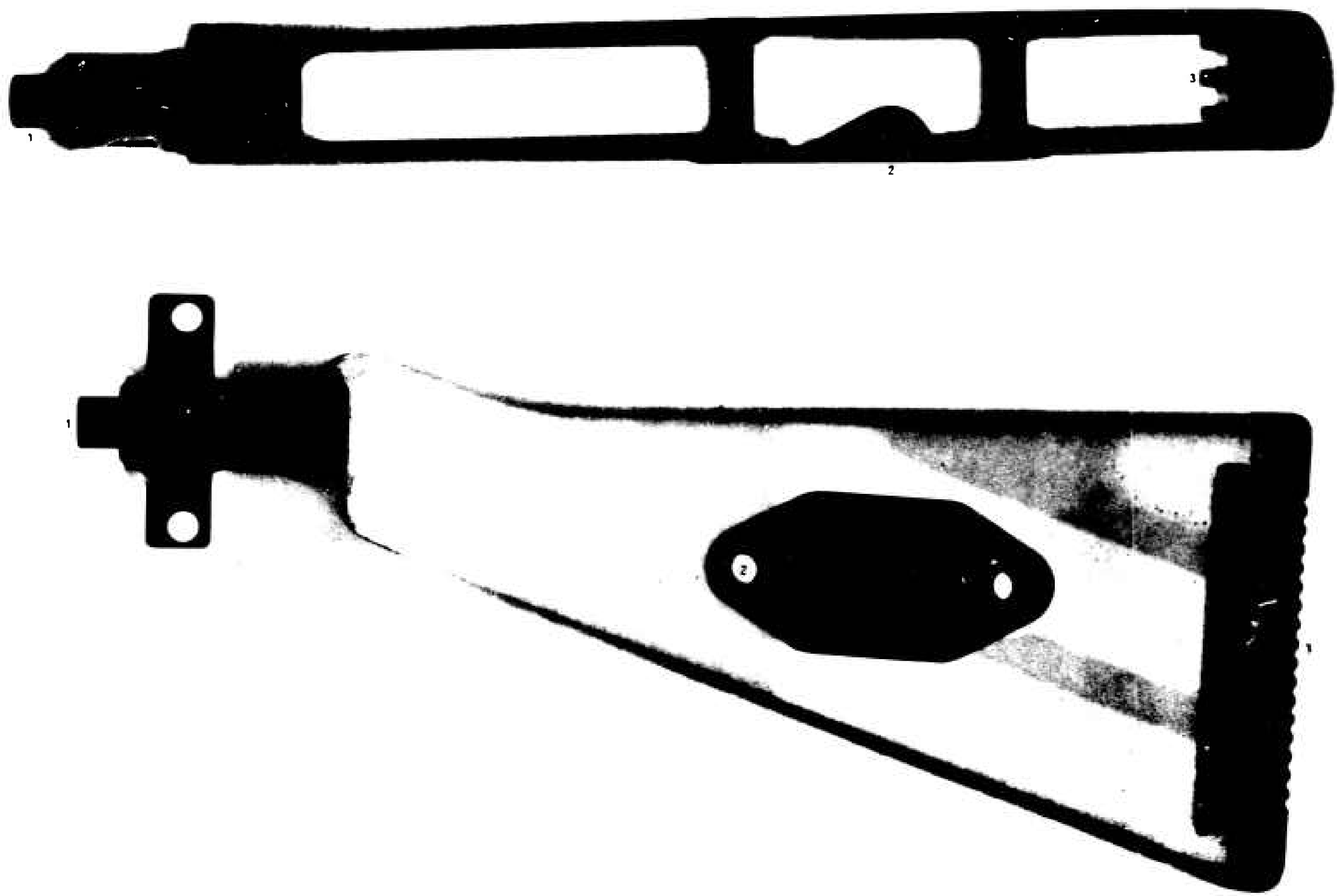


Figure 1.2-3: Radiograph of Top and Left Side Views of HK-23A1 Buttstock. The Buffer Assembly (1), Rear Sling Swivel Base (2), Buttplate (3), and Buttstock Body Wall (4) Are Shown.

The HK-23A1 machine gun received for test could be fired in either a belt-fed configuration as shown in Figure 1.1-1, or in a magazine-fed configuration as shown in Figure 1.2-4. The components added to the basic weapon for belt feed are the feeder assembly, cartridge guide, and bolt-and-carrier assembly. An ammunition container holds 200 rounds of belted ammunition and is attached to the bottom of the feeder assembly by means of four studs on the cover of the box. These studs engage mating rectangular-shaped slots in the feeder. A latch on the feeder securely positions the box and prevents its unintentional removal. The weapon is changed to a 20- or 40-round, conventional, spring-loaded, box-magazine feed (HK-33 rifle magazines) by removing the previously mentioned belt-feed components and replacing them with a different bolt-and-carrier assembly and magazine-adapter assembly; unlinked ammunition is used in this configuration. Photographs comparing the configuration differences of component feed parts are shown in Figures 1.2-5 through 1.2-10. Only the belt-fed configuration was evaluated by firing.

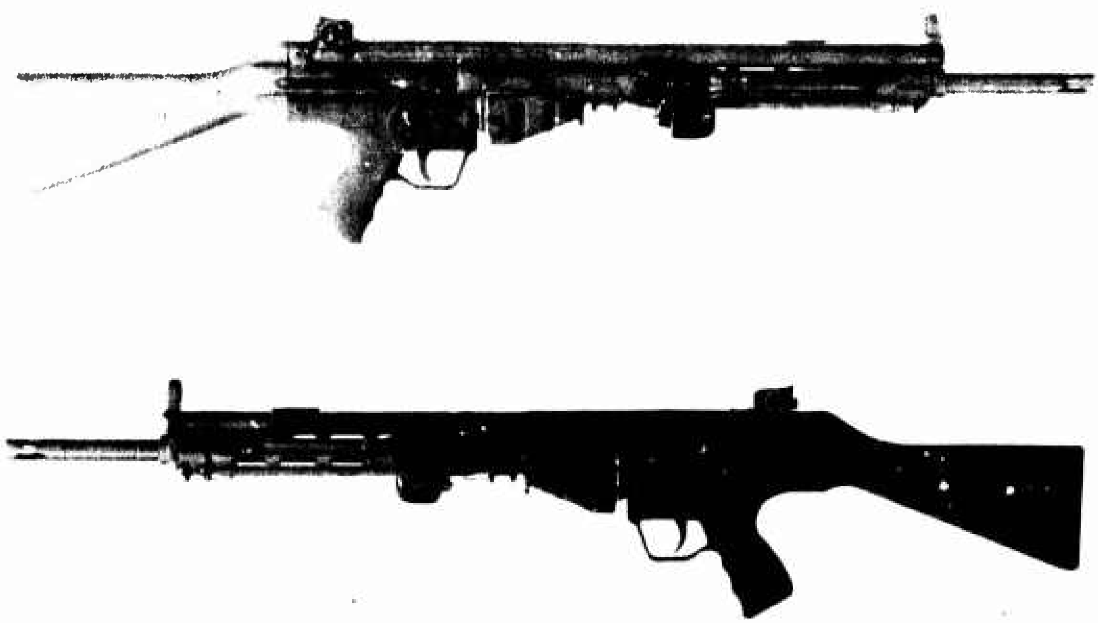


Figure 1.2-4: The 5.56-MM HK-23A1 Machine Gun, Adapted for Magazine Feed. Right (TOP) and Left Sides.

Figure 1.2-5: Comparing Field Disassembly of Belt-Fed Configuration (TOP) and Magazine-Fed Configuration (BOTTOM) of 5.56-MM HK-23A1 Machine Gun.

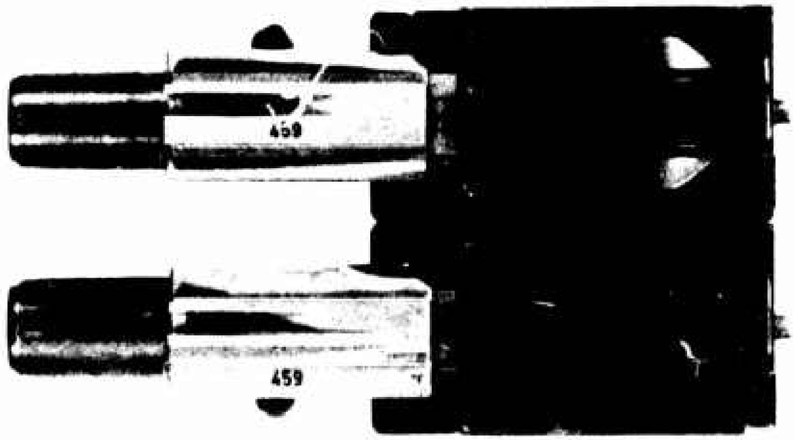


Figure 1.2-6: Difference between Bottoms of HK-23A1 Machine Gun Bolt-and-Carrier Assemblies Used for Belt-Fed (TOP) and Magazine-Fed (BOTTOM) Weapon Configurations.

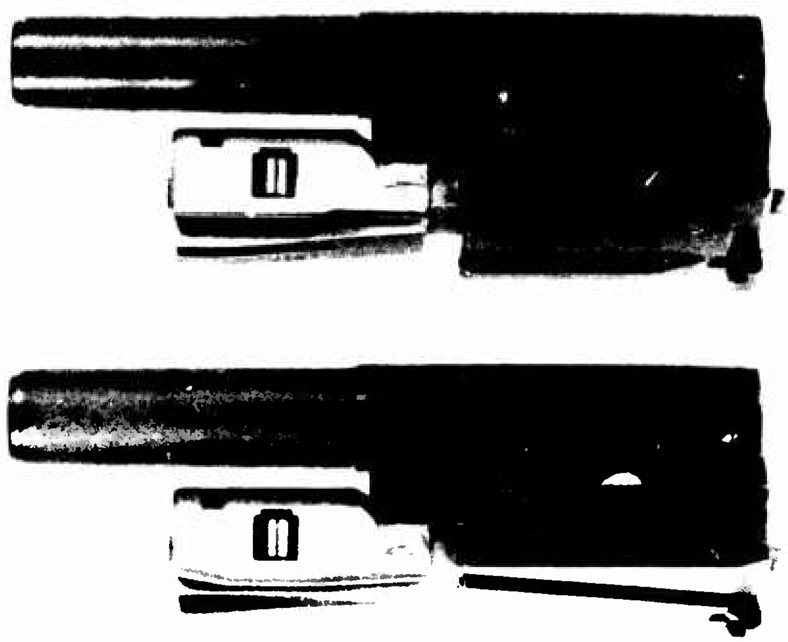
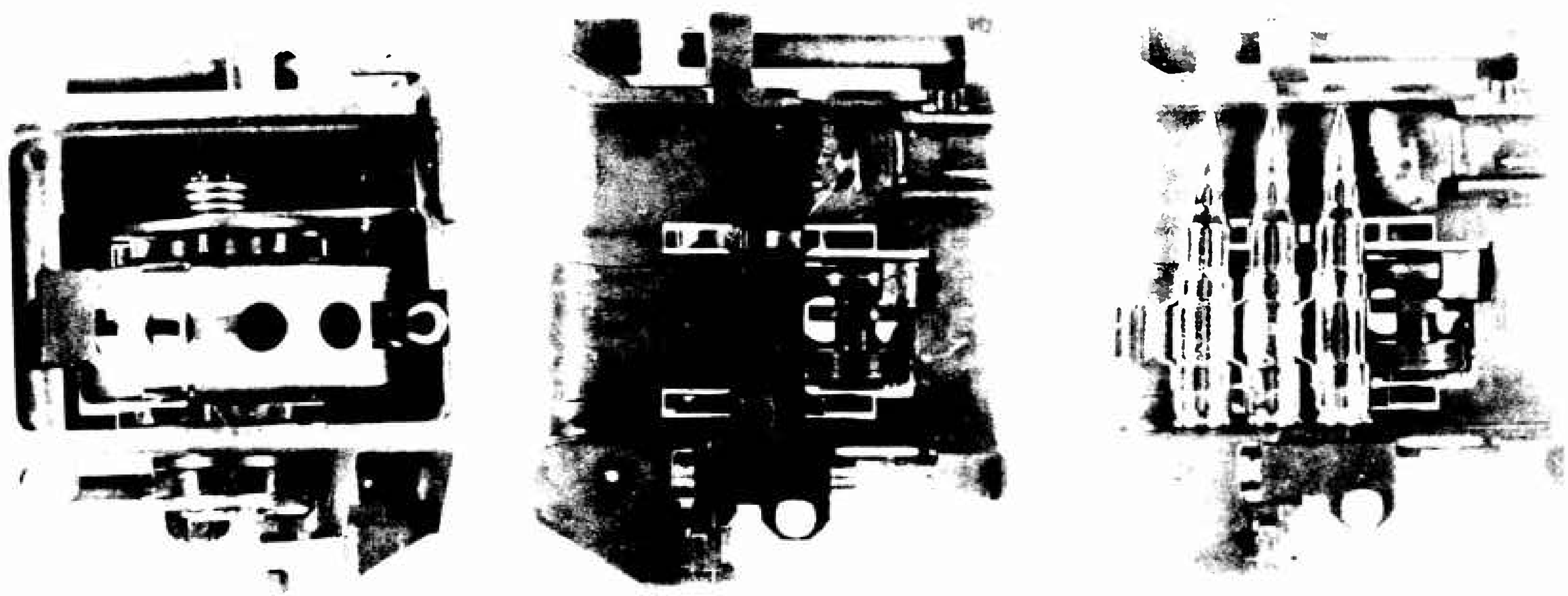


Figure 1.2-7: Difference between Left Sides of HK-23A1 Machine Gun Bolt-and-Carrier Assemblies Used for Belt-Fed (TOP) and Magazine-Fed (BOTTOM) Weapon Configurations.



Bottom View. Top View. Top View with Ammunition in Position to Be Fed Over For Chambering.

Figure 1.2-8: Feeder Mechanism for the 5.56-MM HK-23A1 Machine Gun.

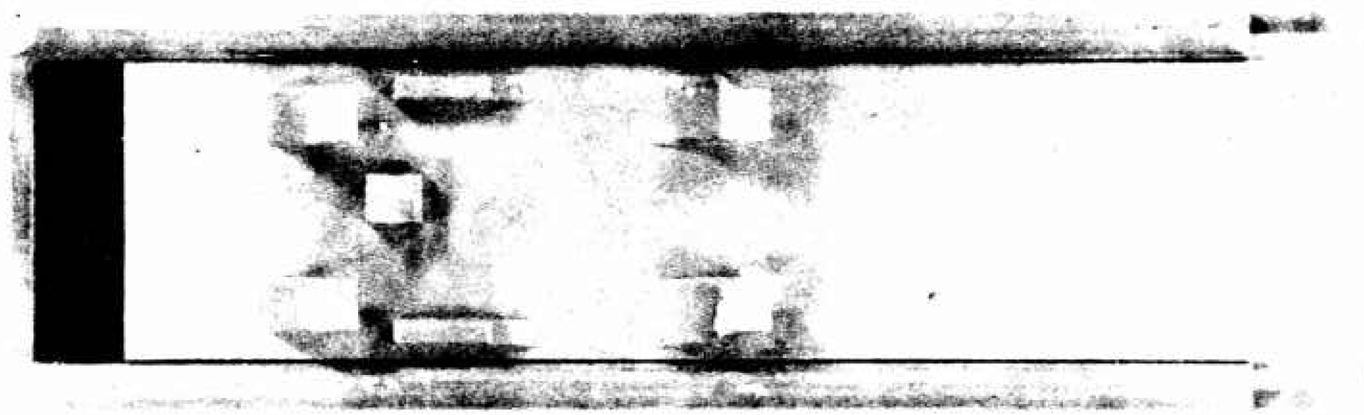


Figure 1.2-9: Top View of 200-Round-Capacity Magazine for Belt-Fed Configuration of 5.56-MM HK-23A1 Machine Gun.

Figure 1.2-10: Assembled (LEFT) and Disassembled Views of 40- and 20-Round-Capacity Magazines for the 5.56-MM HK-23A1 Machine Gun; Magazine Adapter Is Shown Next to Assembled 20-Round Magazine.

Three different barrel types were provided for use with ammunition of varying characteristics. The external barrel configuration of the three types was identical, the difference being in the rifling rate of twist. Figure 1.2-11 shows the marking designations on these barrels. Table 1.2-1 provides information on the appropriate combination of cartridge, rifling rate of twist, and locking-piece angle necessary for the proper functioning in both belt-fed and magazine-fed weapon configurations.

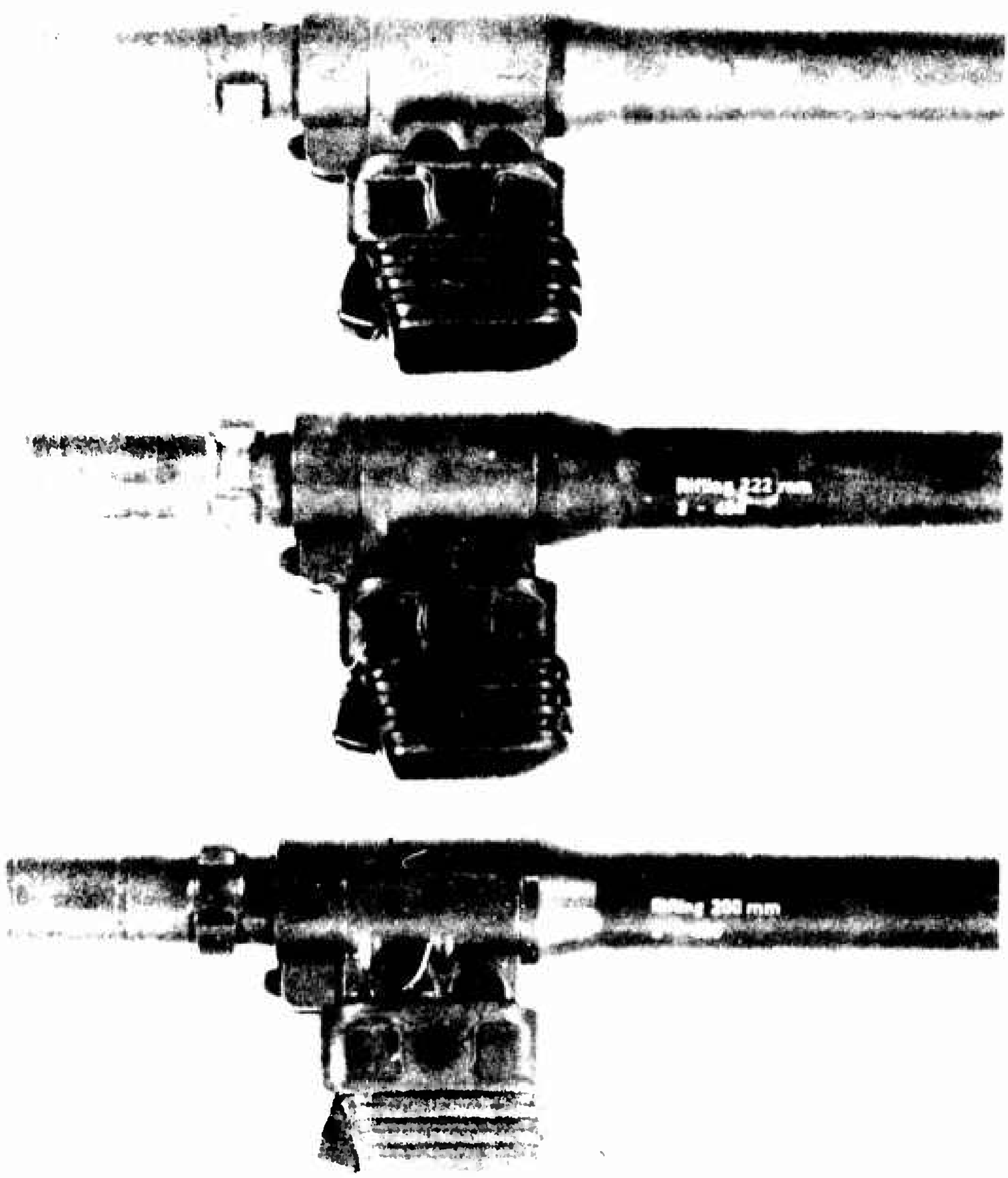


Figure 1.2-11: Three Different Barrel Types for the 5.56-MM HK-23A1 Machine Gun.

Table 1.2-1. Weapon Component Configurations

Ammunition Type	Type of Feed Mechanism	Length of One Turn in Rifling MM	Length of One Turn in Rifling In.	Locking-Piece Angle, deg[a]
M193 and M196[b]	Belt	305	12.0	54
	Magazine	305	12.0	50
XM287 and XM288[c]	Belt	222	8.7	50
	Magazine	222	8.7	48
IWK 77 Grains[d]	Belt	200	7.9	50
	Magazine	200	7.9	48

[a]Included angle of locking piece. Half the angular measurement is to either side of the longitudinal centerline of the part.
[b]Standard US ball and tracer ammunition.
[c]Heavy ball and tracer ammunition used in this test; US-developed and manufactured by IVI in Canada.
[d]Heavy ball ammunition manufactured in Germany.

The removable bipod is shown in Figure 1.2-12. The fixed-length legs are locked in either the folded or erected position by the spring-loaded latch in each leg. Although the barrel is basically of a fixed (non-adjustable) headspace design, a timing gage (Figure 1.2-13) was provided as part of the maintenance support package to be used to insure that the relative locations of the locking components of the weapon were correct at the time of firing. The gage was inserted between the back of the bolt head and the front shoulder of the bolt-head carrier. If release of the hammer occurred within the maximum/minimum limits of the gage (i.e., 0.5 to 1.0 mm), timing was considered to be correct.

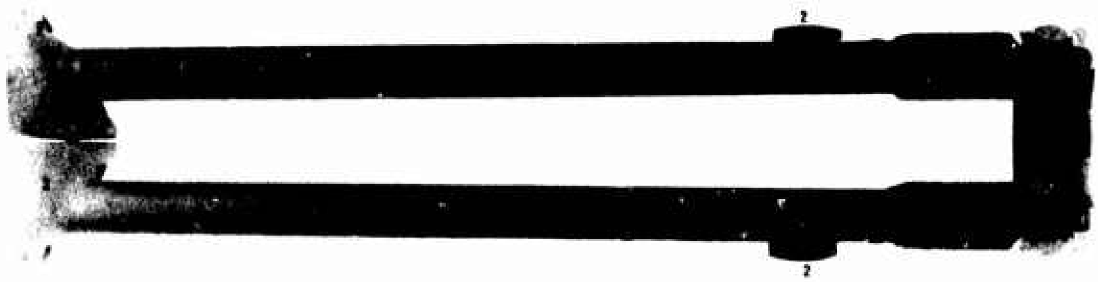


Figure 1.2-12: Folded Bipod for 5.56-MM HK-23A1 Machine Gun. Numbers Indicate Locations of (1) Yoke, (2) Leg Latches, and (3) Feet.

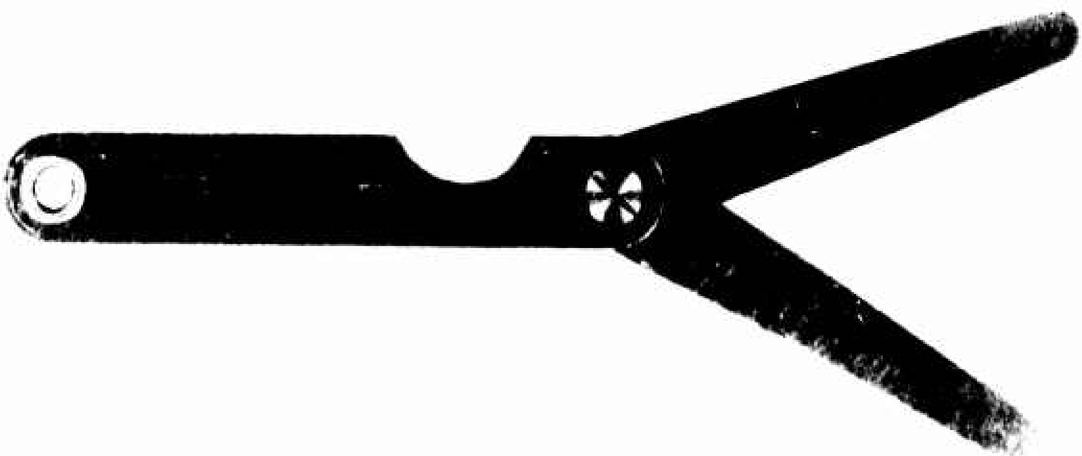


Figure 1.2-13: Timing Check Gage.

Two slings were provided with the weapon. One was designated as a firing sling, which was used during underarm firing for better weapon control; the other was designated a carrying sling and was used for transporting the weapon.

Both slings are pictured in Figure 1.2-14.

Figure 1.2-14: Firing Sling (LEFT) and Carrying Sling (RIGHT) for the 5.56-MM HK-23A1 Machine Gun.

Table 1.2-2 provides information on the weights and measurements of the ammunition. Table 1.2-3 provides similar information about the weapon. Firing-pin indent was measured in copper cylinders. No indent occurred as a result of bolt closure (inertial effects). An average indent of 0.012 inch was obtained by hammer impact on the firing pin. The trigger-pull force was 12 pounds in both the semiautomatic and fully automatic modes, and 11 pounds in the controlled 5-round-burst mode.

Table 1.2-2. Ammunition[a] Weights and Measurements

Weights						Length Measurements, inches			
Grains				Pounds					
Complete Rd	Proj	Prop.	Empty Primed Case	200-Rd Linked 4/1	200 Links	Comp Rd	Case	Proj	200-Rd Linked 4/1
Cartridge Type: Ball, XM287.									
190.2	68.2	26.5	95.5	6.29	0.82	1.856	1.755	0.918	94.0
Cartridge Type: Tracer, XM288.									
180.1	58.8	25.9	95.4	-	-	1.847	1.755	0.994	-

[a]Ammunition was manufactured by IVI of Canada.

Table 1.2-3. Weapon Weights and Measurements

Characteristics	Weight, lb	Measurements, in. except as indicated
Weapon, without ammunition[a]	15.64	-
Empty 200-round magazine box	1.41	-
Spare barrel	3.47	-
Bipod	1.28	-
Sling, carrying type	0.39	-
Sling, firing type	0.44	-
Over-all length	-	39.7
Over-all width:		
Without magazine	-	4.8
With magazine	-	10.7
Width of bipod, legs erected	-	13.8
Over-all height	-	13.2
Barrel length[b]	-	18.9
Sight radius	-	23.0
Stock, length of pull	-	15.0
Stock, pitch of butt	-	+3°

[a]Includes bipod.
[b]Six-groove rifling, right-hand twist.

The included 50° angle of the bolt lock measured prior to firing, measured 25° 05' on the right side and 25° 04' on the left side, for an actual included angle of 50° 09'.

The average barrel-change time from the prone, bipod-supported position (right-handed shooter) was 7 seconds. The individual trial records were 8, 9, 7, 6, 5, 6, 5, 5, 10, and 6 seconds. The barrel can be removed and replaced when hot without the use of additional hand protection other than as provided by the hand grip on the barrel assembly. Table 1.2-4 presents the magazine-change and loading-time data. These data were recorded only for the belt-fed weapon configuration using the 200-round-capacity magazine box.

Table 1.2-4. Loading Times for 200-Round-Capacity Magazine Recorded during Initial Inspection

	Data, seconds					
Trial	Test Personnel No.					Avg
No.	1	2	3	4	5	No.
			Magazine Loading Time			
1	35	27	36	39	45	36
2	41	17	40	34	35	33
3	45	50	29	27	33	37
Avg	40	31	35	33	38	35
			Magazine Change Time[a]			
1	23	37	30	26	28	29
2	34	24	27	32	21	28
3	21	25	24	30	26	25
Avg	26	29	27	29	25	27

[a]All were right-handed personnel. Time includes that to remove empty magazine, install new (fully loaded) magazine, and chamber round preparatory to firing. No leader tabs were available to pull the cartridges through the feeder. Shooters were in the prone, bipod-supported position.

A photograph of the weapon, disassembled in detail, is in Figure 1.2-15; a list of the various weapon components, numerically keyed to the photograph, is in Table 1.2-5.

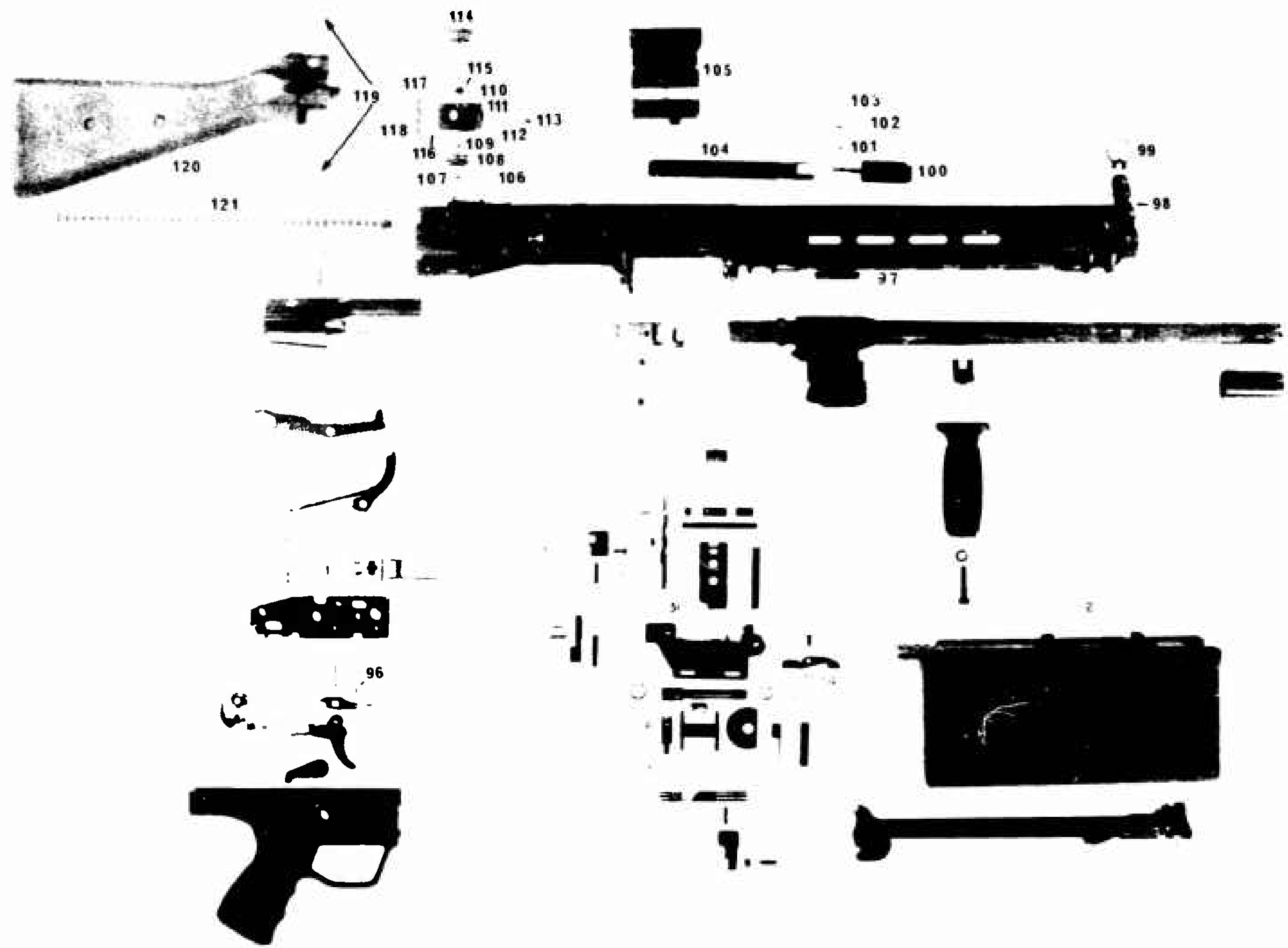


Figure 1.2-15: Detailed Disassembly of 5.56-MM HK-23A1 Machine Gun in Belt-Fed Configuration. Component Parts Are Keyed Numerically to Table 1.2-5.

Table 1.2-5. Parts List for 5.56-MM Heckler and Koch Machine Gun, Model 23A1

Part No.[a]	Part
1	Bipod assembly
2	200-round magazine assembly
3	Front grip screw
4	Front grip screw washer
5	Front grip
6	Front grip screw retaining clip
7	Front grip attachment plate
8	Muzzle cap
9	Barrel assembly
10	Front follower pin
11	Front follower spring
12	Front follower
13	Control bolt screw
14	Control bolt (feeder)
15	Ratchet spring (control ring)
16	Control ring assembly (feeder)
17	Sprocket wheel (feeder)
18	Protective disc
19	Elbow spring
20	Catch holder assembly (feeder)
21	Safety washer (control spindle)
22	Safety washer (control spindle)
23	Control spindle (feeder)
24	Safety washer (magazine latch lever)
25	Lever (magazine latch)
26	Lever pin (magazine latch)
27	Feeder pivot pin
28	Feeder housing
29	Rear follower
30	Control slide spindle
31	Locking lever spring (feeder)
32	Control slide plunger
33	Control slide spring
34	Guide bushing (control slide plunger)
35	Locking lever (feeder)
36	Locking lever pin (feeder)
37	Locking lever stop pin
38	Locking lever retaining pin
39	Control wheel (feed cam follower)
40	Control slide spindle key
41	Control slide pin
42	Control slide
43	Safety washer (control wheel)

[a]As shown in Figure 1.2-15.

Table 1.2-5 (Cont'd)

Part No.[a]	Part
44	Control wheel spring (feed cam follower spring)
45	Control wheel spring holder (feed cam follower spring support)
46	Rear follower pin
47	Safety washer (rear follower pin retainer)
48	Spacer - long
49	Spacer (rear follower spring guide)
50	Spacer - short
51	Rear follower spring
52	Pistol grip
53	Selector
54	Trigger
55	Trigger spring
56	Sear pin detent plunger spring
57	Sear pin detent plunger
58	Sear pin
59	Sear (automatic)
60	Trigger housing
61	Ratchet pin (burst control)
62	Ratchet spring (burst control)
63	Ratchet wheel (burst control)
64	Burst control ratchet pawl assembly consisting of:
64a	Control lever
64b	Transport lever
64c	Catch
64d	Burst control ratchet pawl pin
65	Transport lever spring
66	Catch spring
67	Catch/release lever
68	Disconnector pin
69	Trigger spring guide
70	Disconnector spring and roller assembly
71	Catch flap (burst control sear)
72	Burst control sear spring
73	Burst control sear pin
74	Trigger connecting bar spring
75	Hammer spring
76	Hammer pin
77	Hammer assembly
77a	Hammer
77b	Hammer strut
77c	Hammer strut pin
78	Ejector spring
79	Ejector

[a]As shown in Figure 1.2-15.

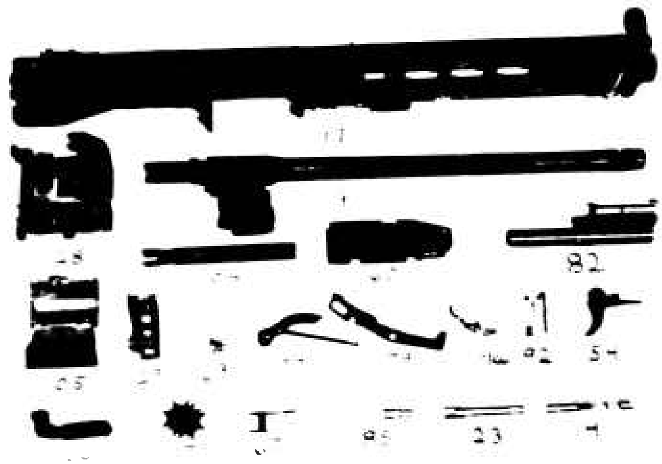
Table 1.2-5 (Cont'd)

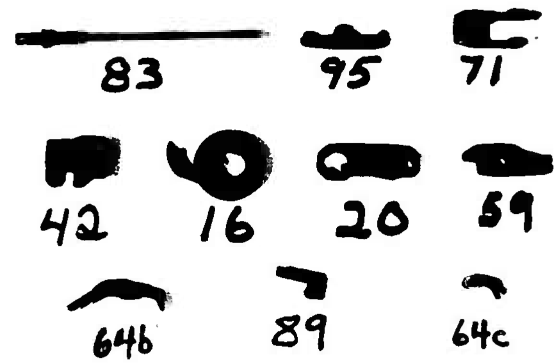
Part No.[a]	Part
80	Ejector pivot clip ring
81	Ejector pivot
82	Bolt-head carrier (welded assembly)
83	Firing pin
84	Firing pin spring
85	Locking piece
86	Locking roller stop pin
87	Locking roller retainer
88	Locking roller (2)
89	Extractor
90	Extractor pin
91	Extractor spring
92	Bolt head
93	Bolt latch spring
94	Bolt latch pin
95	Bolt head locking lever
96	Sear detent spring retaining pin
97	Receiver
98	Front sight aperture retaining pin
99	Front sight aperture
100	Cocking lever assembly
101	Cocking lever return spring bushing
102	Cocking lever return spring
103	Cocking lever assembly pin
104	Cocking lever support
105	Cartridge guide
106	Rear sight shaft nut cotter pin
107	Rear sight shaft nut
108	Windage adjustment knob
109	Windage zero adjustment screw
110	Rear sight base assembly
111	Rear sight base washer
112	Rear sight base lock washer
113	Rear sight base screw
114	Elevation knob and shaft assembly
115	Elevation indexing cam
116	Rear sight elevation and windage detent spring
117	Rear sight elevation and windage detent
118	Rear sight elevation and windage detent retaining pin
119	Buttstock retaining pin assembly (2) (4 parts)
120	Buttstock assembly
121	Operating spring assembly (10 parts)

[a]As shown in Figure 1.2-15.

Only a limited evaluation for disassembly and assembly was made. Field disassembly required 20 seconds; the time to reassemble was 65 seconds. Detailed disassembly required 23 minutes; reassembly took a total of 1 hour and 56 minutes (not including time spent while slave pins, necessary for reassembly of the feeder, were made). A detailed discussion is presented in paragraphs 1.5.2 and 1.6.2.

Figure 1.2-16 depicts and identifies the 30 weapon components which were selected for magnetic-particle inspection to determine if incipient cracks or other material discontinuities were present that would constitute a safety hazard during firing or would adversely affect weapon operation. This inspection revealed minor cracks in five parts (Figures 1.2-17 through 1.2-21). The extents of the cracks are in Table 1.2-6. None of these cracks were considered to be a bar to testing for either functional or safety reasons, although the hammer failed during function firing (para 1.4.2).





APG Part No.	Part Name	APG Part No.	Part Name
9	Barrel assembly	64c	Catch
14	Control bolt (feeder)	67	Catch/release lever
16	Control ring assembly (feeder)	71	Catch flap
17	Sprocket wheel (feeder)	77	Hammer assembly
20	Catch holder assembly (feeder)	79	Ejector
23	Control spindle (feeder)	82	Bolt head carrier
28	Feed housing	83	Firing pin
29	Rear follower assembly (feeder)	85	Locking piece
42	Front follower (feeder)	89	Extractor
54	Trigger	92	Bolt head
59	Sear (automatic)	95	Bolt head locking lever
60	Trigger housing	97	Receiver
63	Ratchet wheel (burst control)	100	Cocking lever assembly
64a	Control lever	104	Cocking lever support
64b	Transport lever	105	Cartridge guide

Figure 1.2-16: Component Parts of the HK-23A1 Machine Gun that Were Subjected to a Magnetic-Particle Inspection.

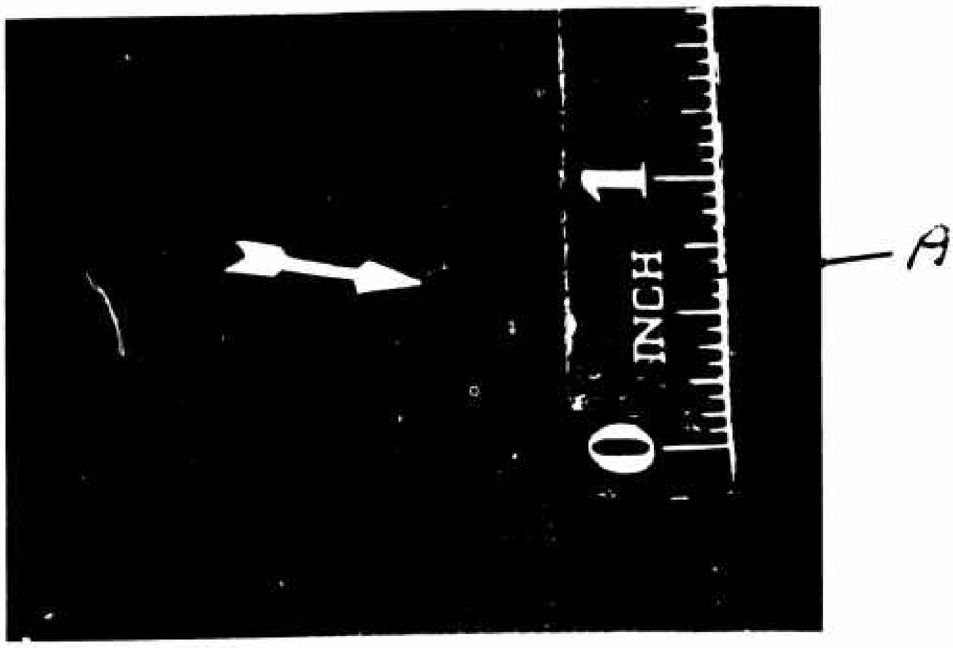


Figure 1.2-17: Multiple Cracks at Location A of APG Part No. 104 (Cocking-Lever Support) in Area of Connecting Pin Hole, Before Firing.

Figure 1.2-18: Crack (Arrow) at Location A of APG Part No. 29 (Rear Follower Assembly, Feeder) before Firing.

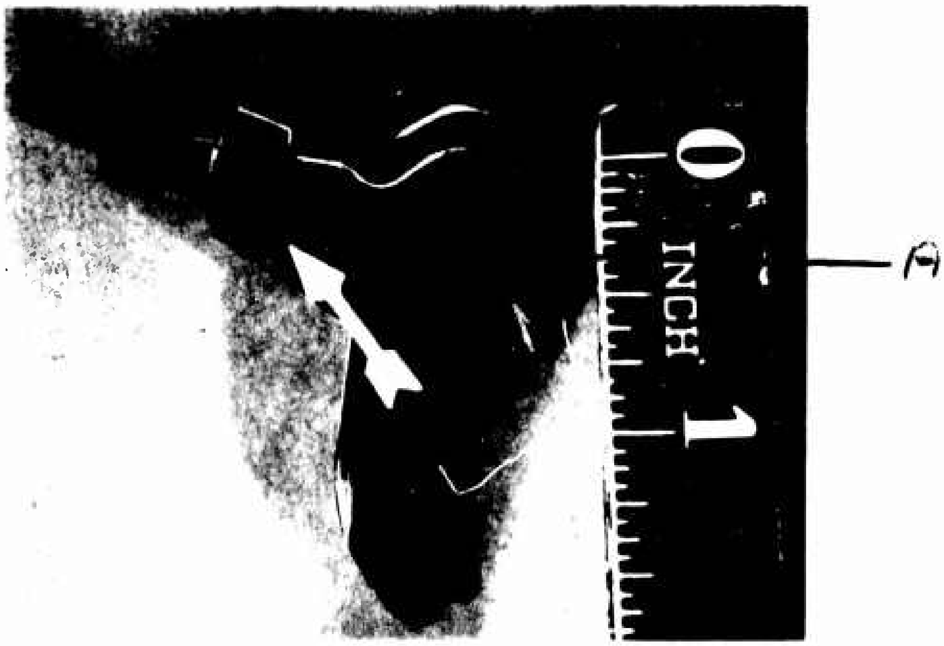


Figure 1.2-19: Multiple Cracks (Arrow) at Location A of APG Part No. 54 (Trigger) before Firing.

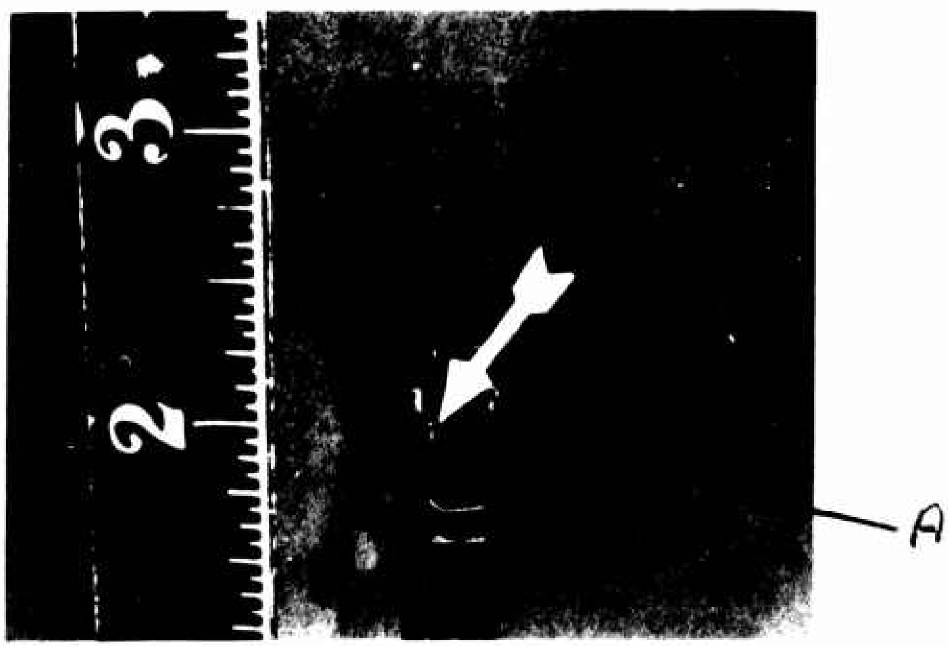


Figure 1.2-20: Crack (Arrow) at Location A of APG Part No. 77 (Hammer) in Thin Web of Hammer Strut Hole, before Firing.

Figure 1.2-21: Crack (Arrow) at Location A of APG Part No. 97 (Receiver) in Spot-Weld, Before Firing.

Table 1.2-6: Crack Dimensions of Component Parts Shown in Figures 1.2-16 to 1.2-21

APG Part No.	Part Name	Crack Length, inches	
		Right Side	Left Side
29	Rear follower assembly (feeder)	1/32	-
54	Trgger	5/16, 3/16	-
77	Hammer	3/32	-
97	Receiver	1/8	-
104	Cocking lever support	1/4	1/4

Tables 1.2-7 and 1.2-8 present the data for the XM287 ball and XM288 tracer ammunition evaluated for velocity and pressure at controlled temperatures of +155, +125, +70, and -65°F. The data presented in Table 1.2-7 for pressure, velocity and action time (vented pressure barrel), and Table 1.2-8 for velocity (unvented accuracy barrel) are uncorrected values (i.e., no correction factor was derived from concurrent firing of reference rounds because no reference ammunition was available). An inspection of the fired cases revealed that there were no blown or leaky primers and no distortion of the cartridge-case head when firing the test ammunition from a locked-breech universal receiver mechanism.

Table 1.2-7. Pressure, Velocity, and Action-Time Summary (Pressure Barrel)

Charac-teristics	Data							
	XM287 Ball Ammunition				XM288 Tracer Ammunition			
	Temperature, °F				Temperature, °F			
	+155	+125	+70	-65	+155	+125	+70	-65
Port Pressure, psi								
MAX	12,800	14,400	14,700	13,600	12,900	12,800	13,000	12,100
MIN	11,500	10,100	12,300	12,500	11,000	11,600	11,400	11,100
ES	1,300	4,300	2,400	1,100	1,900	1,200	1,600	1,000
AVG	12,210	13,120	13,175	13,115	11,805	12,335	12,080	11,505
[c]STD	360	808	558	325	595	137	387	282
Chamber Pressure, psi								
MAX	50,900	[a]52,400	52,000	49,000	[b]52,000	52,600	47,000	41,300
MIN	45,000	46,800	45,400	43,500	43,000	43,400	41,900	36,600
ES	5,900	5,600	6,600	5,500	9,000	9,200	5,100	4,700
AVG	47,795	49,584	49,295	45,885	47,284	47,595	44,645	39,350
[c]STD	1,962	1,584	1,642	1,436	2,393	2,750	1,278	1,220
Velocity, fps								
MAX	2,970	2,980	2,949	2,931	3,144	3,135	2,966	2,869
MIN	2,839	2,900	2,840	2,779	2,928	2,932	2,863	2,808
ES	131	80	109	152	216	203	103	61
AVG	2920.0	2934.2	2909.0	2867.3	3047.0	3028.3	2922.4	2837.1
[c]STD	32.25	22.70	30.22	32.77	64.08	63.74	27.39	20.91
Action Time, ms								
MAX	1.38	1.36	1.37	2.31	1.33	1.44	2.03	1.39
MIN	1.21	1.24	1.24	1.27	1.18	1.19	1.26	1.27
ES	.17	.12	.13	1.04	.15	.25	.77	.12
AVG	1.26	1.30	1.28	1.44	1.24	1.28	1.35	1.34
[c]STD	.043	.033	.035	.345	.049	.064	.168	.036

[a]Excluding one pressure of 62,600 psi.
[b]Excluding one pressure of 66,900 psi.
[c]Standard Deviation.

Table 1.2-8. Velocity Summary (Accuracy Barrel)

Temp, °F	No. Rd Fired	Bbl No.	Velocity, fps Max	Min	ES	Avg	STD
			XM287 Ball				
+155	20	3	3088	2909	179	2989.3	44.39
	20	5	3057	2923	134	2987.7	37.07
+125	20	3	3033	2907	126	2987.0	31.19
	20	5	3034	2917	117	2981.1	32.22
+70	20	3	3032	2895	137	2954.7	37.39
	20	5	2984	2881	103	2945.7	29.07
-65	18	3	2938	2760	178	2874.7	52.17
	19	5	2977	2798	179	2922.8	46.07
			XM288 Tracer				
+155	20	3	3185	2940	245	3073.8	73.80
	20	5	3193	2948	245	3057.3	67.05
+125	20	3	3163	2951	212	3068.8	67.16
	20	5	3181	2936	245	3073.9	68.17
+70	20	3	3015	2819	196	2934.1	38.93
	20	5	2977	2880	97	2924.6	30.18
-65	20	3	2871	2696	175	2797.9	44.82
	19	5	2922	2804	118	2870.6	34.75

Initial firings of the HK-23A1 machine gun (three single rounds and one cumulative 20-round automatic burst) were conducted in a darkened range from a fixed mount for the purpose of observing muzzle and breech flash. Figure 1.2-22 illustrates the muzzle-flash characteristics of the tracer ammunition. There was no visible breech flash with either type of ammunition, and no muzzle flash with the ball ammunition.

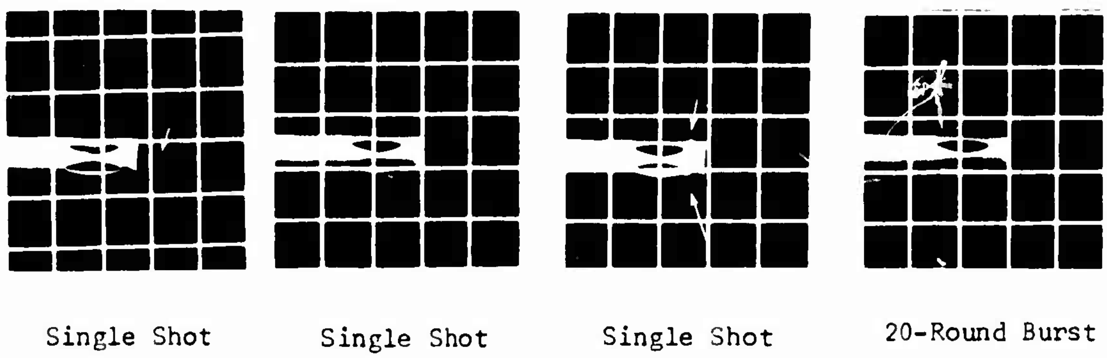


Figure 1.2-22: Muzzle-Flash Characteristics of the 5.56-MM HK-23A1 Squad Automatic Weapon Fired with XM288 Tracer Ammunition. Grid Scale is One Inch. Arrows Indicate Location of Flash in the Immediate Area of the Suppressor.

Figure 1.2-23 presents the data for the first hand-held firing of the weapon in contact with the shooter's body, which was accomplished during the evaluation of the effects of gunsmoke on target obscuration and weapon signature. Figure was conducted from the prone, bipod-supported position. One 25-round automatic burst was fired; the results were photographed immediately after firing the last round. The wind velocity at the time of firing was from left to right of the shooter at 3 mph.

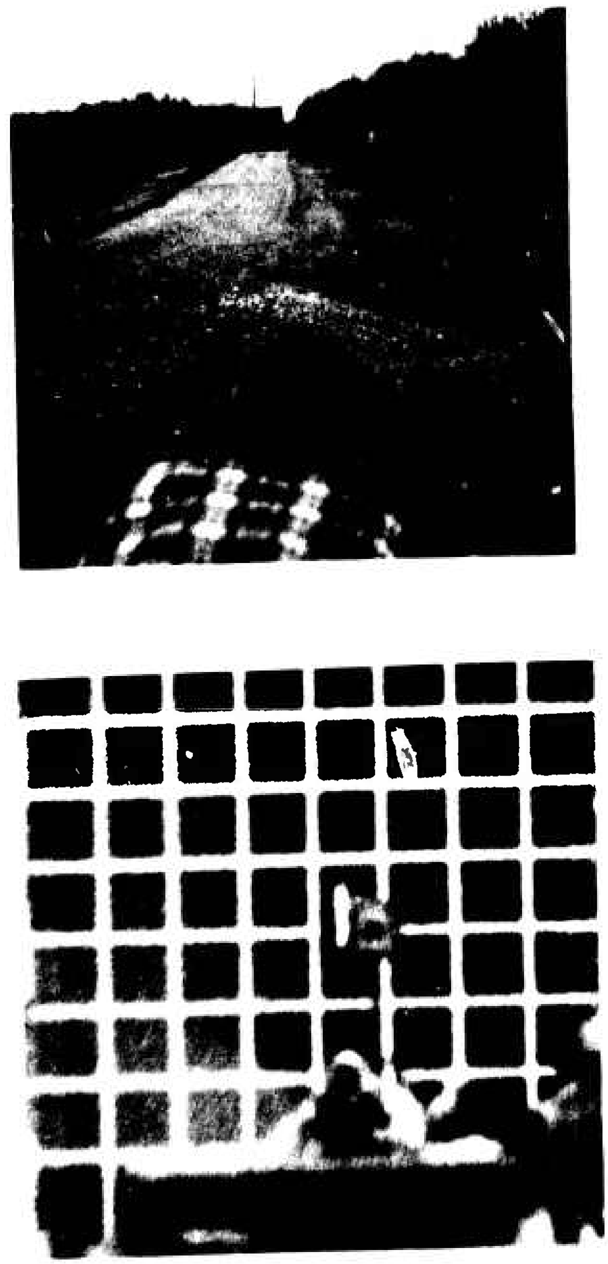


Figure 1.2-23: Effects of Gun Smoke on Target Obscuration (TOP) and Weapon Signature (BOTTOM) at 100-Meter Range. Target Grid is 12 Inches (One-Inch-Wide Grid Lines).

Table 1.2-9 presents the function performance data for the final phase of this subtest, which was the firing of one magazine box load of ammunition (200 rounds) from the prone, bipod-supported position to check functioning and assess the handling characteristics necessary to operate this weapon safely. All maintenance and human-factors data are reported in paragraphs 1.5 and 1.6 respectively.

There was one occurrence of a blown primer; however, the cartridge-case head was not swollen.

1.2.3 Analysis

The HK-23A1 machine gun was considered to be safe to fire from the shoulder. The ammunition was considered to be safe to use.

The weapon design relative to misassembly of component parts was found to be unsatisfactory. A full discussion and analysis of the attendant problems are presented in paragraphs 1.5 and 1.6.

Table 1.2-9. Function Performance Data for Initial Inspection and Safety Evaluation

Barrel No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rounds Fired[b] Subtest Mag.	Subtest Cycle	Subtest Total	Cum Wpn	Function Performance Type	Class	Chg To	Cyclic Rate[c] Before	Cyclic Rate[c] After	Maintenance[d] S	Maintenance[d] U
Initial Pre-Firing Inspection														
													O	
Flash Test Phase														
							0	FFR	III	P	-	-		F
1	1	Ball	SS	-	4	4	4	Sat						
1	2	Ball	FA	-	20	24	24	Sat						
1	3	Tracer	SS	-	3	27	27	Sat						
1	4	Tracer	FA	-	20	47	47	Sat						
Smoke Test Phase														
1	5	4/1	FA	-	25	72	72	Sat			853			
													F	
Function Phase														
1	6	Ball	5B	0	0	72	292	FFR	III	P	-	-		
1				3	3	75	295	FFR	I	PR	-	-		
1				2	5	77	297	FFR	I	PR	-	-		
1				1	6	78	298	FSU	I	PR	-	-		
1				2	8	80	300	FSU	I	PR	-	-		O
1		4/1	5B	30	38	110	330	FFR	II	W	856	869		
1				24	62	134	354	FBC	II	WR	850	-		
1				1	63	135	355	FBC	II	WR	-	-		
1				1	64	136	356	FBC	II	WR	-	-		F
2				0	64	136	356	FBC	II	WR	-	810		F
1				35	99	171	391	FFR	I	W	832	784		
1				46	145	217	437	FFR	I	W	844	832		
1				6	151	223	443	FFR	I	W	-	850		
1				57	208	280	500	Sat			-	-		
													F	

[a]XM287 ball, XM288 tracer, 4-XM287/1-XM288 cartridge.
[b]220 rounds fired for accuracy between smoke and function phases.
[c]Recorded immediately before and after a malfunction. Rates not associated with malfunctions are for information.
[d]S = scheduled, U = unscheduled, F = field level, O = organizational level.

Note: Refer to Table 1.5-1 for complete listing of abbreviation definitions.

1.3 ACCURACY AND DISPERSION

1.3.1 Method

This test consisted of firing five 10-round targets (single-shot) from a benchrest at 100 meters range, and five targets (10-round automatic burst) from a prone, bipod-supported position at ranges of 100 and 300 meters. Projectile velocity was recorded at 15 feet from the muzzle over a 20-foot baseline during the benchrest firing phase.

The rectangular coordinates were recorded for each shot. In addition, during automatic burst fire the first ball round at the 100-meter range and the first ball round and two tracer rounds (fifth and 10th rounds in the firing sequence) at the 300-meter range were specifically located on the target by applying lithographic ink to the tip of these projectiles. These projectiles then left a colored imprint on the target.

1.3.2 Results

The results of the accuracy and dispersion testing are presented in five tables. Table 1.3-1 contains the information on 10-round target data. Table 1.3-2 utilizes the information from the previous table and breaks it down by individual round grouping (i.e., first, fifth, 10th, and second through 10th) to determine controllability characteristics. Table 1.3-3 contains velocity data. Cyclic rate of fire data are in Table 1.3-4. Table 1.3-5 contains function performance information.

1.3.3 Analysis

The vertical and horizontal components of dispersion for single-shot benchrest-fired targets are similar in magnitude. This characteristic is due to the fact that the HK-23A1 machine gun is fired from a closed-bolt position, which permits maximum weapon control during the instant prior to firing the rounds.

The change in centers of impact of the shot groups as a result of changing barrels was considered to be acceptable (at the ranges tested).

The weapon was found to be readily controlled by the shooter during automatic burst fire from the prone bipod-supported position (bipod in its forward location on the weapon receiver). The alternate bipod location, which is toward the longitudinal center of the weapon, was not evaluated during this test. Based on prior tests of a similar weapon (G-3 modified to 5.56-mm) during the small-arms weapon system evaluation (SAWS), which was conducted in 1966, when central mounting of the bipod was used, it is suspected that firing from that position will not produce as good results as was demonstrated during this evaluation. (Reference para 2.1.5.3 c Report No. DPS-1970, Volume I).

Obscuration of the target by gunsmoke was not noticeable during the firing of single 10-round-burst targets. Observations on this effect during the firings of extended duration are discussed in paragraph 1.5.2.

Table 1.3-1. Accuracy and Dispersion Test Data for HK23A1 Light Machine Gun

Tgt No.	EVD	MVD	VSD	EHD	MHD	HSD	ES	MR	CI		RSD
									H	V	
Ball Ctg		Benchrest (Single-Shot)					Barrel No. 1				100 Meters
H100.161	2.9	0.9	1.1	2.0	0.5	0.7	3.1	1.1	-0.7	-0.3	1.3
H100.162	3.2	0.6	0.9	2.4	0.5	0.7	3.3	0.8	-2.0	1.7	1.1
H100.163	4.1	1.1	1.4	3.1	0.7	0.9	4.1	1.4	-1.9	1.7	1.6
H100.164	4.9	0.9	1.3	3.8	0.8	1.1	5.4	1.3	-2.1	2.7	1.7
H100.165	2.8	0.6	0.8	3.3	0.9	1.1	3.9	1.2	-2.8	2.7	1.4
MEAN	3.6	0.8	1.1	2.9	0.7	0.9	4.0	1.2	-1.9	1.7	1.4
Ball Ctg							Barrel No. 2				
H100.166	3.4	0.8	1.0	4.1	1.0	1.2	4.3	1.3	-2.7	4.2	1.6
H100.167	3.9	0.7	1.1	3.3	0.9	1.2	4.1	1.3	-3.1	3.7	1.6
H100.168	2.4	0.7	0.8	2.5	0.7	0.8	2.9	1.0	-3.0	3.8	1.1
H100.169	4.8	1.0	1.4	4.1	1.1	1.3	5.2	1.6	-1.7	3.4	2.0
H100.170	5.8	1.0	1.5	4.6	1.1	1.4	6.0	1.7	-2.5	3.1	2.1
MEAN	4.1	0.8	1.2	3.7	1.0	1.2	4.5	1.4	-2.6	3.6	1.7
Tracer Ctg							Barrel No. 1				
H100.171	4.0	1.2	1.4	9.6	1.6	2.5	9.7	2.4	-2.8	2.3	2.9
H100.172	5.2	1.4	1.7	9.1	2.1	2.8	10.4	2.6	-2.5	2.4	3.2
H100.173	5.1	1.1	1.5	4.2	0.9	1.2	5.3	1.5	-3.1	1.7	1.9
H100.174	4.6	1.3	1.6	5.8	1.7	2.0	5.9	2.3	-1.5	2.1	2.6
H100.175	8.4	2.2	2.8	14.4	2.8	3.8	15.8	3.8	-1.8	5.2	4.7
MEAN	5.5	1.4	1.8	8.6	1.8	2.5	9.4	2.5	-2.3	2.7	3.1
Tracer Ctg							Barrel No. 2				
H100.176	12.1	2.0	3.1	6.0	1.6	2.0	12.8	2.8	-2.5	3.9	3.6
H100.177	7.0	1.8	2.3	6.7	1.9	2.2	8.0	2.8	-1.6	2.7	3.2
H100.178	9.2	2.3	3.0	6.0	1.5	1.9	9.9	2.9	-1.6	4.7	3.6
H100.179	11.2	2.0	3.1	6.6	1.7	2.1	11.3	3.1	-1.5	4.0	3.7
H100.180	6.2	1.4	1.9	8.2	2.0	2.6	8.3	2.8	-1.9	4.4	3.2
MEAN	9.1	1.9	2.6	6.7	1.7	2.1	10.1	2.9	-1.8	3.9	3.4

Table 1.3-1 (Cont'd)

Tgt No.	EVD	MVD	VSD	EHD	MHD	HSD	ES	MR	CI H	CI V	RSD
Ball Ctg	Prone w/Bipod Support (Automatic Fire)						Barrel No. 1				100 Meters
H100.181	9.8	2.3	3.1	16.4	3.6	4.9	16.5	4.7	-10.6	4.4	5.8
H100.182	6.5	1.6	2.0	18.8	3.7	5.5	19.0	4.3	-14.5	2.1	5.8
H100.183	10.6	2.4	3.3	19.0	2.8	4.8	19.0	4.6	-9.6	1.8	5.8
H100.184	11.7	4.5	5.0	16.1	4.7	5.7	18.9	6.8	-10.1	-3.7	7.6
H100.185	5.6	1.5	1.9	16.4	5.4	6.1	17.0	5.8	-3.6	4.4	6.4
MEAN	8.8	2.5	3.1	17.3	4.0	5.4	18.1	5.2	-9.7	1.8	6.3
4-Ball/1-Tracer Ctg							Barrel No. 1				300 Meters
H1300181	21.8	6.0	7.4	75.1	19.9	24.4	75.9	21.7	-28.6	1.2	25.5
H1300182	33.3	8.3	10.4	35.4	10.8	13.0	46.9	14.5	-14.7	-23.9	16.6
H1300183	33.6	11.4	13.2	47.6	11.9	15.4	47.8	17.6	-17.0	-6.0	20.2
H1300184	23.5	5.7	7.3	76.1	12.6	19.8	79.6	14.7	-43.2	-17.1	21.1
H1300185	34.5	6.5	9.4	75.5	18.9	24.0	78.9	21.1	-40.7	-14.5	25.8
MEAN	29.3	7.6	9.5	61.9	14.8	19.3	65.8	17.9	-28.8	-12.0	21.9
Ball Ctg							Barrel No. 2				100 Meters
H100.186	7.9	1.5	2.2	23.0	4.9	6.5	24.3	5.2	-12.8	-2.1	6.9
H100.187	4.8	1.3	1.6	14.9	4.3	5.1	15.5	4.6	-7.0	2.1	5.4
H100.188	94.4	16.1	28.5	15.7	3.1	4.4	94.9	17.0	-9.9	-11.8	28.8
H100.189	5.0	1.3	1.6	15.4	3.0	4.4	15.6	3.5	-8.2	1.1	4.7
H100.190	11.6	2.3	3.3	20.1	4.5	5.9	21.8	5.4	-11.1	0.7	6.7
MEAN	24.7	4.5	7.4	17.8	4.0	5.3	34.4	7.1	-9.8	-2.0	10.5
4-Ball/1-Tracer Ctg							Barrel No. 2				300 Meters
H1300186	29.5	6.3	8.3	85.2	17.6	24.0	90.2	19.2	-49.0	-7.4	25.4
H1300187	51.8	1.3	14.9	54.2	8.5	15.0	75.0	15.2	-36.8	-12.9	21.1
H1300188	37.3	9.4	12.0	52.4	9.9	14.1	61.5	14.8	-29.0	-22.7	18.5
H1300189	33.7	8.0	10.6	83.3	17.4	24.6	83.3	21.0	-48.1	4.3	26.8
H1300190	38.8	9.5	12.1	77.5	14.5	21.3	77.6	19.7	-44.6	-0.1	24.5
MEAN	38.2	8.9	11.6	70.5	13.6	19.8	77.5	18.0	-41.5	-7.8	23.3

Table 1.3-2. Shot-Group Characteristics by Round of Occurrence in Automatic Burst Fire[a]

Bbl No.	Rd No. Sequence	No. of Rd	Target Measurements, inches[b] EVD	MVD	VSD	EHD	MHD	HSD	ES	MR	CI H	CI V	RSD
			100-Meter Range Using All Ball Ammunition										
1	1	5	0.4	0.1	0.1	2.7	0.6	1.0	2.7	0.6	+ 0.1	+ 1.2	1.0
1	2 to 10	45	18.2	3.4	4.5	24.8	4.2	5.6	26.2	6.2	-10.8	+ 1.9	7.3
2	1	5	1.6	0.4	0.6	1.5	0.5	0.6	1.9	0.7	+ 0.5	+ 1.7	0.9
2	2 to 10	45	98.1	5.0	14.1	21.2	3.7	4.5	98.1	7.1	-11.0	- 2.4	14.8
			300-Meter Range Using 4-Ball/1-Tracer Ammunition Mix										
1	1	5	11.5	3.2	4.4	5.9	1.4	2.1	11.7	3.8	+ 3.0	+ 0.7	4.9
1	5	5	34.7	11.5	14.8	57.6	18.4	22.9	59.8	23.2	-48.0	-11.8	27.2
1	10	5	32.7	9.5	13.3	28.4	9.3	12.0	36.1	15.4	-28.6	-10.8	17.9
1	2 to 10	45	49.4	9.9	12.7	73.4	17.2	20.8	75.5	21.8	-32.4	-13.5	24.4
2	1	5	13.2	3.6	5.2	4.5	1.5	1.9	13.6	4.2	+ 2.7	+ 2.3	5.5
2	5	5	48.4	15.7	19.4	31.5	9.7	12.8	49.0	19.9	-44.8	- 0.1	23.2
2	10	5	39.8	11.6	15.1	59.0	17.7	23.8	67.3	22.0	-52.8	- 6.8	28.2
2	2 to 10	45	69.8	11.8	15.2	65.0	12.4	15.5	70.4	18.9	-46.4	- 8.9	21.7

[a]These data were derived from the same information which was used to compile Table 1.3-1.
[b]Each statistical entry in the table represents the calculated value for data pooled from five targets.

Table 1.3-3. Velocity Data Recorded during the Benchrest Firing Phase of the Accuracy and Dispersion Test

Target Sequence	Instrumental Velocity at 15 Feet, fps — Barrel No. 1 — Ammunition Type: Ball	Barrel No. 1: Tracer	Barrel No. 2: Ball	Barrel No. 2: Tracer
First	2815	3043	2851	2982
Second	2862	3101	2860	2996
Third	2868	3056	2851	2995
Fourth	2864	3067	2847	2999
Fifth	2870	3055	2849	2990
Average	2856	3064	2852	2992

Table 1.3-4. Cyclic Rate of Fire Recorded during 10-Round Automatic Burst Fire Phase of Accuracy and Dispersion Test

Target Sequence	Shots per Minute — Barrel No. 1 — Target Distance, meters: 100	Barrel No. 1: 300	Barrel No. 2: 100	Barrel No. 2: 300
First	881	890	877	873
Second	865	932	869	890
Third	877	908	877	886
Fourth	869	932	865	877
Fifth	856	922	360	873
Average	870	917	870	882

Note: Ball ammunition fired at the 100-meter range, and a cartridge mix of 4-ball/1-tracer at the 300-meter range.

Table 1.3-5. Function Performance Data for Accuracy and Dispersion Test

	Subtest		Mode	No. Rounds Fired[c]				Function Performance					Maintenance[d]	
					Subtest		Cum			Chg	Cyclic Rate			
Barrel No.	Cycle No.	Ammo Type[a]	of Fire[b]	Mag.	Cycle	Total	Wpn	Type	Class	To	Before	After	S	U
					Benchrest Phase									
3	1	B	SS	-	10	10	82	Sat			-	-		
1	1	B	SS	-	55	65	137	Sat			-	-		
2	2	B	SS	-	55	120	192	Sat			-	-		
1	3	T	SS	-	50	170	242	Sat			-	-		
2	4	T	SS	-	50	220	292	Sat			-	-	F	
					100-Meter Bipod Phase									
1	5	B	10B	-	50	270	550	Sat			-	-		
2	6	B	10B	-	50	320	600	Sat			-	-		
					300-Meter Bipod Phase									
2	7	4/1	10B	-	53	373	653	Sat			-	-		
1	8	4/1	10B	-	60	433	713	Sat			-	-	F	

[a]B = Ball XM288, T = tracer XM289, 4/1 = 4-XM288/1-XM289.
[b]SS = Single shot; 10B = 10-round burst.
[c]Function firing of 208 rounds occurred between benchrest and 100-meter bipod phases.
[d]S = scheduled; U = unscheduled, F = field level.

1.4 ENDURANCE TEST AT NORMAL AMBIENT RANGE TEMPERATURE

1.4.1 Method

The weapon was cleaned with PS-661B-type solvent and lubricated with semifluid oil conforming to specification MIL-L-46000A. Firing was conducted in 200-round cycles in accordance with the schedule given in Table 1.4-1. The weapon was cooled after each cycle and was scheduled to be cleaned, inspected, and relubricated after each 10 cycles. Weapon accuracy and dispersion, and projectile velocity and stability were to be checked at each maintenance interval. The cyclic rate of fire was recorded throughout testing when fired from the bipod.

Table 1.4-1. Firing Schedule for 6000-Round Endurance Testing of HK-23A1 Machine Gun[a]

Cycle No.	Mode of Fire	Firing Position
1	5B	Shoulder (standing)
2	5B	Bipod
3	20B	Bipod
4	5B	Bipod
5	5B	Bipod
6	5B	Bipod
7	20B	Hip (standing)
8	5B	Hip (standing)
9	5B	Hip (standing)
[b]10	5B	Hip (standing)

[a]Testing was terminated prior to completion of the remaining 20 cycles, which would have used a firing sequence similar to that shown for the first 10 cycles. Maintenance was scheduled to be performed after each ten 200-round cycles fired.

[b]Not fired.

1.4.2 Results

The test results are presented in four tables. Table 1.4-2 contains accuracy and dispersion data. Table 1.4-3 presents the velocity information. An inspection of the paper screens placed forward of the weapon, for the purpose of determining if the projectiles yawed or broke up during flight, revealed no adverse performance. The cyclic rate-of-fire data are in Table 1.4-4 as part of the functioning performance information. A tabulation of malfunctions by type is in Table 1.4-5.

Photographs were taken during testing to show malfunctions, part failures, and cartridge-case casualties. Figure 1.4-1 displays the characteristic feeding failure (FFO) experienced with this weapon.

Figure 1.4-2 shows a representative sample of cartridge-case casualties that occurred during firing. The casualties are characterized by swelling of the case head and expansion of the primer pocket. There were 51 occurrences of case-head swelling; 36 had blown primers also. Although these characteristic changes in the cartridge case are frequently an indicator of excessive pressures chargeable to the ammunition, the velocity and pressure data obtained using ammunition from the same lot, and the firings of this ammunition from the the weapon during initial inspection and accuracy tests, do not indicate that the ammunition is the cause of the problem.

During the 5-round controlled burst firings, the weapon burst controller periodically failed to count correctly. The acquisition of information relating to the frequency of this malfunction was hampered by the occurrence of other weapon stoppages. There were nine recorded occurrences of 4-round bursts and 14 occurrences of 6-round bursts during 104 malfunction-free attempts to fire in the controlled-burst mode.

Table 1.4-2. Accuracy and Dispersion Data Recorded before Endurance Test for HK23A1 Machine Gun

Target No.	EVD	MVD	VSD	EHD	MHD	HSD	ES	MR	CI H	CI V	RSD
Ball Ctg		Benchrest (Single-Shot)					Barrel No. 1				100 Meters
H-1	3.3	1.0	1.2	2.7	0.7	0.9	4.0	1.3	1.3	0.9	1.5
H-2	2.5	0.5	0.7	3.2	1.0	1.1	3.8	1.2	2.1	1.0	1.4
H-3	2.7	0.7	0.9	3.3	0.7	1.0	3.7	1.1	1.8	0.8	1.3
H-4	4.7	1.1	1.5	2.1	0.6	0.7	5.0	1.3	1.9	0.7	1.6
H-5	2.7	0.8	1.0	2.7	0.7	0.9	3.2	1.2	2.2	1.1	1.3
MEAN	3.2	0.8	1.0	2.8	0.7	0.9	3.9	1.2	1.9	0.9	1.4

Table 1.4-3. Velocity Data Recorded Concurrently with Accuracy Firing, Prior to the Endurance Test

Tgt[a] No.	Avg Vel, fps Max	Min	Ext Var	Avg
H-1	2912	2814	98	2866
H-2	2945	2841	104	2889
H-3	2922	2821	101	2872
H-4	2925	2838	87	2875
H-5	2927	2824	103	2876
Avg[b]	2926	2828	99	2876

[a]Each target consisted of firing 10 rounds of XM287 ball ammunition.
[b]Five-target average.

Table 1.4-4. Function Performance Data for Endurance Test at Normal Ambient Range Temperature

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Mag.	No. Rd Fired: Subtest Cycle	No. Rd Fired: Subtest Total	No. Rd Fired: Cum Wpn	Function Performance: Type	Class	Chg To	Cyclic Rate[b]: Before	Cyclic Rate[b]: After	Maintenance[c]: S	Maintenance[c]: U
Pretest Accuracy and Dispersion Phase														
1	1	B	SS	-	53	53	766	Sat						
1	1	4/1	5B	5	58	58	771	FFR	I	W	-	-		
				19	77	77	790	FFR	I	W	-	-		
				26	103	103	816	FFR	I	W	-	-		
				23	126	126	839	FFR	I	W	-	-		
				39	165	165	878	FFR	I	W	-	-		
				35	200	200	913	FFR	I	W	-	-		
				31	231	231	944	FFR	I	W	-	-		
				22	253	253	966	Sat			-	-		
1	2	4/1	5B	47	47	300	1013	FFR	I	W	1052	1052		
				34	81	334	1047	FFO	I	W	1012	1012		
				17	98	351	1064	FFO	I	W	1175	1009		
				18	116	369	1082	FFO	I	W	1080	1012		
				8	124	377	1090	FFO	I	W	1052	1019		
				6	130	383	1096	FFO	I	W	1019	1041		
				6	136	389	1102	FFR	I	W	1041	1012		
				9	145	398	1111	FS	I	W	1052	1038		
				8	153	406	1119	FFO	I	W	1052	1009		
				9	162	415	1128	FFO	I	W	999	1012		
				8	170	423	1136	FFO	I	W	1025	1041		
				6	176	429	1142	FFO	I	W	1041	987		
				8	184	437	1150	FS	I	W	1052	1025		
				16	200	453	1166	Sat			-	-		

See footnotes at end of table.

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired Mag.	Subtest Cycle	Total	Cum Wpn	Function Performance Type	Class	Chg To	Cyclic Rate[b] Before	After	Maintenance[c] S	U
1	3	4/1	20B	12	12	465	1178	FS	I	W	1052	1022		
				15	27	480	1193	FFO	I	W	1038	1052		
				9	36	489	1202	FFO	I	W	1052	-		
				1	37	490	1203	FFR	I	W	-	1019		
				6	43	496	1209	FS	I	W	1019	1021		
				8	51	504	1217	FFO	I	W	1021	1052		
				12	63	516	1229	FFR	I	W	-	1052		
				4	67	520	1233	FFO	I	W	1052	1025		
				5	72	525	1238	FFR	I	W	1025	1025		
				9	81	534	1247	FFO	I	W	1025	999		
				4	85	538	1251	FFR	I	W	999	1090		
				4	89	542	1255	FFO	I	W	1090	1046		
				15	104	557	1270	FFO	I	W	1070	1021		
				9	113	566	1279	FFO	I	W	1021	1012		
				7	120	573	1286	FFO	I	W	1012	1038		
				5	125	578	1291	FFR	I	W	1038	1025		
				3	128	581	1294	FFO	I	W	1025	999		
				3	131	584	1297	FFR	I	W	999	-		
				1	132	585	1298	FFR	I	W	-	-		
				1	133	586	1299	FFR	I	W	-	1033		
				7	140	593	1306	FFO	I	W	1033	1028		
				8	148	601	1314	FFO	I	W	1028	1052		
				8	156	609	1322	FFO	I	W	1052	1041		
				6	162	615	1328	FFR	I	W	1041	1038		
				9	171	624	1337	FFO	I	W	1038	1044		
				8	179	632	1345	FFO	I	W	1044	999		
				2	181	634	1347	FFR	I	W	999	999		
				5	186	639	1352	FFO	I	W	999	-		
				1	187	640	1353	FL	I	W	-	-		
				1	188	641	1354	FFR	I	W	-	-		

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Mag.	No. Rd Fired: Subtest Cycle	No. Rd Fired: Subtest Total	No. Rd Fired: Cum Wpn	Function Performance: Type	Function Performance: Class	Function Performance: Chg To	Function Performance: Cyclic Rate[b] Before	Function Performance: Cyclic Rate[b] After	Maintenance[c] S	Maintenance[c] U
				1	189	642	1355	FL	I	W	-	999		
				2	191	644	1357	FFR	I	W	999	991		
				7	198	651	1364	FL	II	W	991	-		F
				2	200	653	1366	Sat						
1	4	4/1	5B	7	7	660	1373	FFO	I	W	1110	1052		
				4	11	664	1377	FFO	I	W	1052	1038		
				9	20	673	1386	FFR	I	W	1052	1016		
				4	24	677	1390	FFR	I	W	1016	-		
				1	25	678	1391	FFO	I	W	-	999		
				8	33	686	1399	FFO	I	W	1052	1033		
				4	37	690	1403	FFR	III	W	1033	1038		O
				8	45	698	1411	FS	I	W	1025	1012		
				7	52	705	1418	FFO	I	WR	1052	1066		
				7	59	712	1425	FFO	I	W	1110	999		
				80	139	792	1505	FFO	I	W	975	989		
				9	148	801	1514	FFO	I	W	1016	999		
				15	163	816	1529	FFO	I	W	1012	999		
				15	178	831	1544	FFO	I	W	999	987		
				6	184	837	1550	FFO	I	W	987	1025		
				0	184	837	1550	FFR	I	WR	-	-		
				0	184	837	1550	FFR	I	WR	-	-		
				0	184	837	1550	FL	I	WR	-	-		F
				16	200	853	1566	Sat						
1	5	4/1	5B	8	8	861	1574	FFO	I	W	1052	999		
				31	39	892	1605	FFO	I	W	999	999		
				8	47	900	1613	FFO	I	W	1052	1025		
				9	56	909	1622	FFO	I	W	1016	1038		
				5	61	914	1627	FFO	I	W	1038	983		F
				4	65	918	1631	FL	II	W	983	1033		
				4	69	922	1635	FFO	I	W	1033	1025		
				7	76	929	1642	FFO	I	W	1052	1012		

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Mag.	No. Rd Fired: Subtest Cycle	No. Rd Fired: Subtest Total	No. Rd Fired: Cum Wpn	Function Performance: Type	Class	Chg To	Cyclic Rate[b]: Before	Cyclic Rate[b]: After	Maintenance[c]: S	Maintenance[c]: U
				8	84	937	1650	FFO	I	W	1025	979		
				8	92	945	1658	FFO	I	W	1052	1012		
				7	99	952	1665	FFO	I	W	1052	1012		
				16	115	968	1681	FFO	I	W	-	1052		
				2	117	970	1683	FFO	I	W	1052	1052		
				6	123	976	1689	FFO	I	W	1052	1052		
				2	125	978	1691	FFO	I	W	1052	1019		
				12	137	990	1703	FFO	I	W	1066	1012		
				10	147	1000	1713	FFO	I	W	1012	999		
				6	153	1006	1719	FFO	I	W	-	1012		
				9	162	1015	1728	FFO	I	W	1033	1009		
				8	170	1023	1736	FFO	I	W	1175	1038		
				7	177	1030	1743	FFO	I	W	1175	1052		
				9	186	1039	1752	FFO	I	W	1016	1025		
				7	193	1046	1759	FFO	I	W	1052	-		
				7	200	1053	1766	Sat						
1	6	4/1	5B	7	7	1060	1773	FFO	I	W	1052	1052		
				6	13	1066	1779	FFO	I	W	-	1016		
				7	20	1073	1786	FFO	I	W	1052	1052		
				7	27	1080	1793	FFO	I	W	1110	1052		
				9	36	1089	1802	FFO	I	W	1016	1052		
				24	60	1113	1826	FFO	I	W	1070	1066		
				6	66	1119	1832	FFO	I	W	-	1080		
				8	74	1127	1840	FFO	I	W	1025	1052		
				2	76	1129	1842	FFO	I	W	1052	1012		
				8	84	1137	1850	FFO	I	W	1052	1012		
				7	91	1144	1857	FFO	I	W	1110	1066		
				8	99	1152	1865	FFO	I	W	1080	1066		
				5	104	1157	1870	FFO	I	W	1066	1052		
				2	106	1159	1872	FFO	I	W	1052	824		

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Mag.	Subtest Cycle	Total	Cum Wpn	Function Performance: Type	Class	Chg To	Cyclic Rate[b]: Before	After	Maintenance[c]: S	U
				6	112	1165	1878	FFO	I	W	824	-		
				7	119	1172	1885	FFO	I	W	-	1080		
				8	127	1180	1893	FFO	I	W	1052	1052		
				2	129	1182	1895	FFO	I	W	1080	1052		
				5	134	1187	1900	FFO	I	W	1052	1095		
				3	137	1190	1903	FFO	I	W	1095	1025		
				7	144	1197	1910	FFO	I	W	1025	1126		
				9	153	1206	1919	FFO	I	W	1175	1095		
				6	159	1212	1925	FFO	I	W	1070	1086		
				1	160	1213	1926	FFO	I	W	1086	-		
				7	167	1220	1933	FFO	I	W	-	1052		
				8	175	1228	1941	FFO	I	W	1052	1030		
				6	181	1234	1947	FFO	I	W	1110	1030		
				3	184	1237	1950	FFO	I	W	1030	975		
				5	189	1242	1955	FFO	I	W	975	1025		
				11	200	1253	1966	Sat						
1	7	4/1	5B	3	3	1256	1969	FFO	I	W	-	-		
				5	8	1261	1974	FFO	I	W	-	-		
				3	11	1264	1977	FFO	I	W	-	-		
				5	16	1269	1982	FFO	I	W	-	-		
				2	18	1271	1984	FFO	I	W	-	-		
				6	24	1277	1990	FFO	I	W	-	-		
				2	26	1279	1992	FFO	I	W	-	-		
				5	31	1284	1997	FFO	I	W	-	-		
				2	33	1286	1999	FFO	I	W	-	-		
				7	40	1293	2006	FFO	I	W	-	-		
				2	42	1295	2008	FFO	I	W	-	-		F
				13	55	1308	2021	FFO	I	W	-	-		
				7	62	1315	2028	FFO	I	W	-	-		
				0	62	1315	2028	FL	II	WR	-	-		F
				20	82	1335	2048	FF	I	W	-	-		

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Mag.	No. Rd Fired: Subtest Cycle	No. Rd Fired: Subtest Total	No. Rd Fired: Cum Wpn	Function Performance: Type	Class	Chg To	Cyclic Rate[b]: Before	Cyclic Rate[b]: After	Maintenance[c]: S	Maintenance[c]: U
			FA	16	98	1351	2064	FF	I	W	-	-		
			5B	19	117	1370	2083	FFR	II	W	-	-		F
				3	120	1373	2086	FFO	I	W	-	-		
				7	127	1380	2093	FFO	I	W	-	-		
				16	143	1396	2109	FF	I	W	-	-		
				19	162	1415	2128	FFR	II	W	-	-		F
				12	174	1427	2140	FFO	I	W	-	-		
				7	181	1434	2147	FFO	I	W	-	-		
				19	200	1453	2166	Sat						
1	8	4/1	5B	7	7	1460	2173	FFO	I	W	-	-		
				8	15	1468	2181	FFO	I	W	-	-		
				0	15	1468	2181	FL	I	W	-	-		
				7	22	1475	2188	FFO	I	W	-	-		
				7	29	1482	2195	FS	I	W	-	-		F
				7	36	1489	2202	FS	I	W	-	-		F
				23	59	1512	2225	FFO	I	W	-	-		
				15	74	1527	2240	FFO	I	W	-	-		
				5	79	1532	2245	FS	I	W	-	-		
				8	87	1540	2253	FS	I	W	-	-		
				7	94	1547	2260	FFO	I	W	-	-		
				7	101	1554	2267	FS	I	W	-	-		
				7	108	1561	2274	FS	I	W	-	-		
				5	113	1566	2279	FFO	I	W	-	-		
				10	123	1576	2289	FFO	I	W	-	-		
				7	130	1583	2296	FS	I	W	-	-		
				5	135	1588	2301	FS	I	W	-	-		
				8	143	1596	2309	FS	I	W	-	-		
				7	150	1603	2316	FS	I	W	-	-		
				17	167	1620	2333	FS	I	W	-	-		
				7	174	1627	2340	FS	I	W	-	-		
				9	183	1636	2349	FS	I	W	-	-		

Table 1.4-4 (Cont'd)

Bbl No.	Subtest Cycle No.	Ammo Type[a]	Mode of Fire	No. Rd Fired: Subtest Mag.	Subtest Cycle	Total	Cum Wpn	Function Performance: Type	Class	Chg To	Cyclic Rate[b] Before	After	Maintenance[c] S	U
				7	190	1643	2356	FFR	I	W	-	-		
				10	200	1653	2366	Sat			-	-		
1	9	4/1	5B	18	18	1671	2384	FFO	I	W	1080	1038		
				9	27	1680	2393	FFO(LJ)	II	W	1052	1066		
				7	34	1687	2400	FFO	III	W	1110	-		0

[a]B = ball; 4/1 = 4 ball, 1 tracer.
[b]Cyclic rates recorded immediately before and after a malfunction.
[c]S = scheduled; U = unscheduled; F = field, O = organizational.

Note: Testing was terminated prior to completion of the scheduled 6000-round test due to safety and and functioning performance problems. Refer to Table 1.6-1 for further abbreviations.

Table 1.4-5. Malfunction Tabulation
by Firing Cycle No. and Type
HK-23A1 Machine Gun

Firing Position	Cycle No.	Total No. of Malfunctions[a] FFR	FFO[b]	FS	FL	FF[c]	Total	No. Rd Fired
Shoulder	1	7	0	0	0	0	7	200
Bipod	2	2	9	2	0	0	13	200
Bipod	3	12	16	2	3	0	33	200
Bipod	4	5^2	11^1	1	1^1	0	18^4	200
Bipod	5	0	22	0	1	0	23	200
Bipod	6	0	29	0	0	0	29	200
Hip	7	2	17	0	1^1	3	23^1	200
Hip	8	1	8	13	1	0	23	200
Hip	9	0	3	0	0	0	3	34
Over-all total	9	29	115	18	7	3	172	1634
Chargeable total	9	27	114	18	5	3	167	1634

[a]Superscript numbers (5^2 etc.) indicate the number of nonchargeable system failures which are included. All others are chargeable. Refer to Table 1.6-1 for failure definitions.

[b]Round to left of fed position when bolt was retracted after closing on empty chamber.

[c]Round in fed position when bolt was retracted after closing on empty chamber.

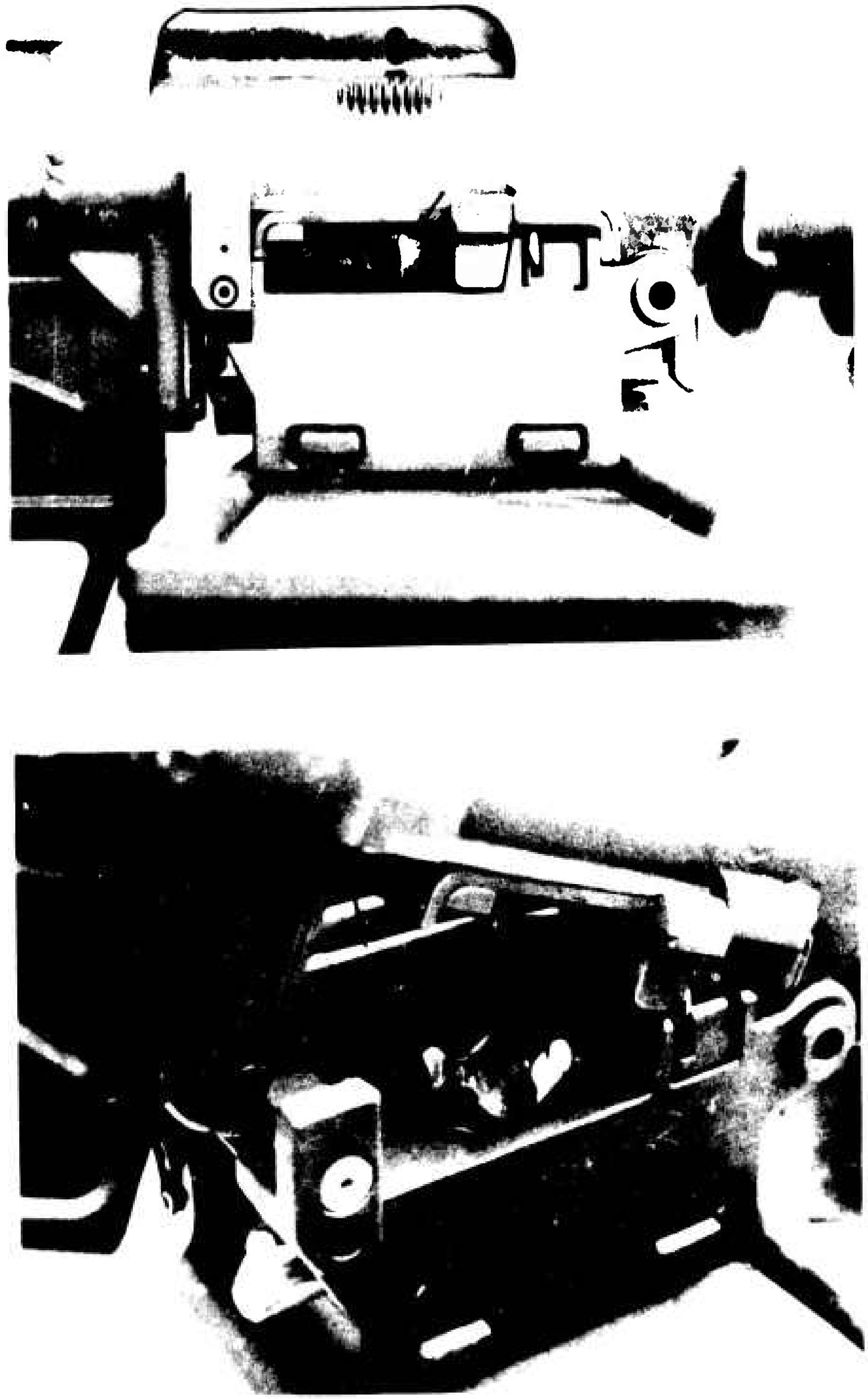


Figure 1.4-1: Typical 5.56-MM HK-23A1 Machine Gun Feeding Failure (FFO) Right Side of Feeder with Link Jammed (Arrow at Top). Same Condition with Feeder Pivoted away From Receiver to Show Location of Link and Ammunition (Arrows at Bottom).

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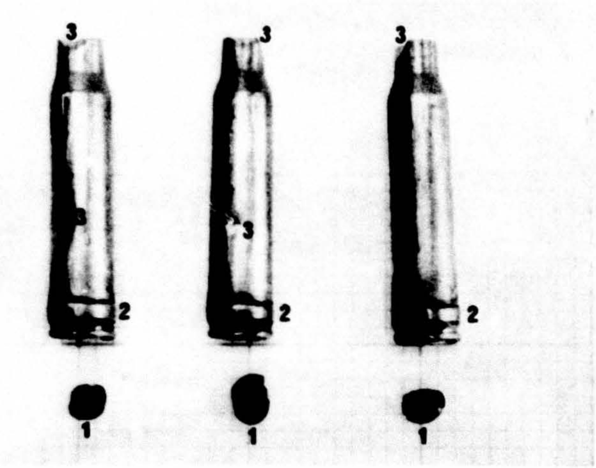

Figure 1.4-2: Cartridge Case Casualties of the 5.56 x 45-MM Cases Fired in an HK-23A1 Machine Gun with Fluted Chamber. No. 1: Blown Primers. No. 2: Radially Bulged Case Heads. Case Neck and Body Indentations (No. 3) Are Ejection Marks. The Longitudinal Striations on the Case Neck Are Chamber Flute Marks.

1.4.3 Analysis

The two basic problems encountered with the HK-23A1 machine gun were excessive feeding failures and fired-case casualties. The feeding failures were apparently caused by a malfunction of the feeder mechanism, which did not reliably index ammunition into the proper position to be chambered. Failure-to-fire stoppages were frequently caused by primer fragments preventing complete closure of the bolt. These fragments (from blown primers) resulted when cartridge-case head distortion occurred. This distortion indicates that the weapon was not fully locked when fired, or that it prematurely unlocked after firing. (A timing check using the gage provided as part of the maintenance support package indicated that the timing was within limits.

In order to positively identify the basic causes of these problems so that they could be corrected, a complete kinematic analysis of the weapon mechanism would have to be conducted. The limited evaluation performed here only identified the problems.

The unknown cause of cartridge-case head swelling was classified as a (potential) safety hazard, Category III, critical, in accordance with MIL-STD-822 (Deficiency).

The functioning performance of the weapon was classified as deficient, due to the high frequency of stoppages, although the majority were readily clearable by immediate action.

1.5 MAINTENANCE EVALUATION

1.5.1 Method

The data generated during the firing tests (i.e., para 1.2 to 1.4) were collectively presented in this subtest for all scheduled and unscheduled maintenance actions. An assessment of malfunctions was made. Other aspects of maintenance including safety, parts replacement, and design for maintainability were investigated. The human-factors aspects of the maintenance operations are presented in paragraph 1.6.

1.5.2 Results

A complete listing of the abbreviations used throughout testing and their definitions is in Table 1.5-1.

Table 1.5-1. List of Abbreviations and Definitions

Abbreviation	Definitions
5-B	Five-round burst
10-B	Ten-round burst
20-B	Twenty-round burst
SS	Single-shot
B	Ball (ammunition)
T	Tracer (ammunition)
4/1	Ammunition linked in the ratio of 4 ball to 1 tracer round
W	Weapon
A	Ammunition
P	Personnel error
R	Repetitive (i.e., WR = weapon repetitive)
F	Field (maintenance level)
O	Organizational (maintenance level)
FS	Failure to strip round from belt during chambering of round
FFO	Failure to feed round over into chambering position, after retracting bolt which closed on empty chamber
FFR	Failure to fire
FL	Failure to lock
FF	Failure to feed (round in fed position when bolt retracted after closing on empty chamber
Class I	Class I malfunction defined as clearable by immediate action within 10 seconds time, without the use of tools or spare parts
Class II	Class II malfunction defined as clearable within 10 minutes with tools and spare parts available to the user as part of the on-weapon maintenance equipment
Class III	Class III malfunction defined as not clearable within 10 minutes and requiring tools and spare parts not available to the user as part of the on-weapon maintenance equipment

Table 1.5-1 (Cont'd)

Abbreviation	Definitions
C	Chargeable malfunction defined as one that is not non-chargeable
N	Nonchargeable malfunction defined as personnel error, instrumentation- or facility-caused malfunction, or a repetitive stoppage that is corrected. (Repetitive malfunctions caused by design deficiencies are chargeable if not corrected during test. Repetitive personnel errors caused by design deficiencies are chargeable.)
FM	Fixed mount
S	Fired from shoulder (standing position)
H	Fired from hip (standing position)
B	Fired from a prone, bipod-supported position
IVI	Industrie Val Cartier (Canadian ammunition manufacturer)
Vel	Velocity
Sat	Satisfactory
IWK	Industrie Werke Karlsruhe (German ammunition manufacturer)
MRBF	Mean rounds between failure
HK	Heckler and Koch
MG	Machine gun
EVD	Extreme vertical dispersion
MVD	Mean vertical dispersion
VSD	Vertical standard deviation
EHD	Extreme horizontal dispersion
MHD	Mean horizontal dispersion
HSD	Horizontal standard deviation
ES	Extreme spread
MR	Mean radius
H	Horizontal
V	Vertical
CI	Center of impact
RSD	Radial standard deviation

Malfunctions that occurred throughout the firing tests, assessed by subtest, class, and category, are presented in Table 1.5-2.

Table 1.5-2. HK-23A1 Machine-Gun Malfunction Assessment

Reference to Subtest Table No.	No. Rd Fired	Malf Type	No. of Malfunctions										
			Malfunction Category										
			Chargeable							Nonchargeable			
			Malfunctions Chargeable to										
			Weapon			Personnel				All others			
			Malfunction Class										
			I	II	III	I	II	III	Total	I	II	III	Total
1.2-9	294	FFR	3	1	0	0	0	2	6	2	0	0	2
		FSU	0	0	0	0	0	0	0	2	0	0	2
		FBC	0	0	0	0	0	0	0	0	4	0	4
1.3-5	433	None	0	0	0	0	0	0	0	0	0	0	0
1.4-4	1634	FFR	24	2	1	0	0	0	27	2	0	0	2
		FFO	114	0	0	0	0	0	114	1	0	0	1
		FS	18	0	0	0	0	0	18	0	0	0	0
		FL	3	2	0	0	0	0	5	1	1	0	2
		FF	3	0	0	0	0	0	3	0	0	0	0
Over-all totals		-	165	5	1	0	0	2	173	8	5	0	13

The HK-23A1 machine-gun design incorporated several safety features. The projectile of a round being chambered was directed past the case head of another round already chambered and thereby prevented accidental ignition of the chambered round due to impact of the bullet nose on the primer. The weapon is designed not to fire with the barrel in an unlocked position; this is due to the misalignment of the extractor recess in the face of the barrel, which prevents full forward travel and locking of the bolt head. However, because the weapon fires from the closed-bolt position, there is a possibility of sustaining a cartridge cook-off if a round chambered in a hot barrel is not immediately fired.

The delayed blowback (roller locked), fluted-chamber design of the weapon allows a greater amount of propellant gases to exit out of the weapon breech and into the area of a shooter's face than is normally associated with gas- or recoil-operated, rotary-locked breech weapons of the same caliber. This condition, while not a definite safety hazard, does cause the shooter's eyes to become momentarily irritated when firing from a prone position for sustained periods.

The safety of the shooter can conceivably be endangered by the cartridge-case head-distortion condition if it progresses to the point of a catastrophic case failure. Testing was terminated prior to attainment of this condition, for reasons of safety. (Refer to para 1.4.2 for further discussion of this safety hazard.)

A list of the component part failures that occurred during the test is presented in Table 1.5-3. Representative samples of the type of failure experienced with the catch/release lever and hammer are shown in Figures 1.5-1 and 1.5-2 respectively.

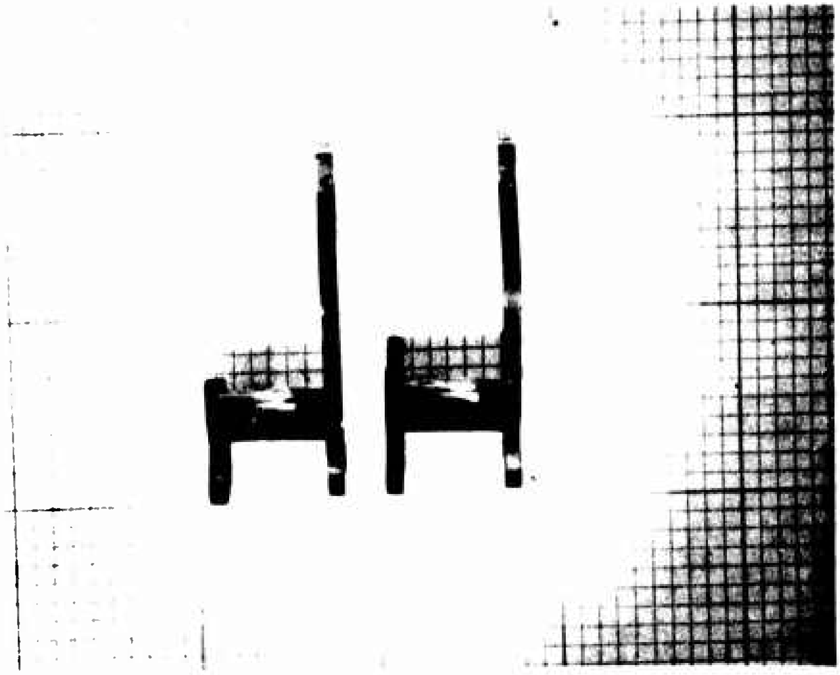

Figure 1.5-1: Two Catch/Release Levers, Deformed during Weapon Assembly (Arrows). Grid Scale = 1/10 Inch.

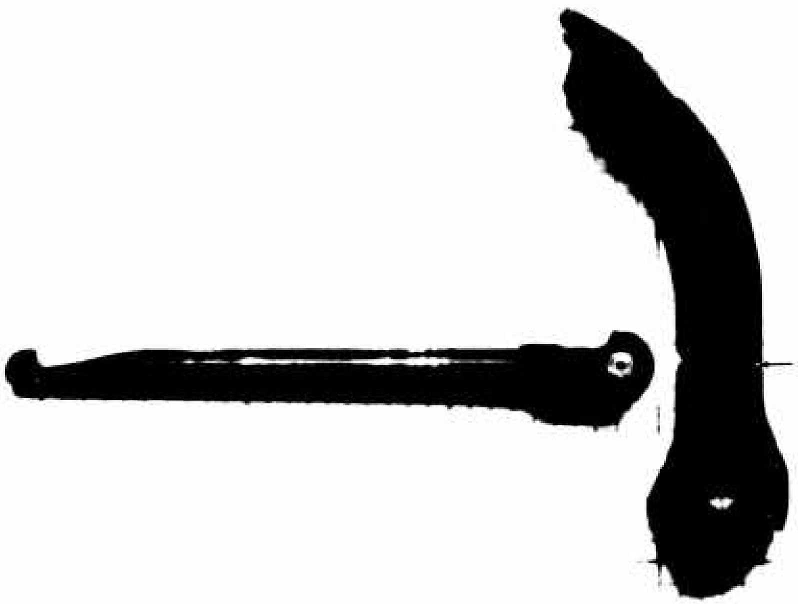

Figure 1.5-2: Broken Hammer (Arrow). Hammer Strut Is at Left. Failure Originated through the Hammer Strut Pin Hole in Hammer.

The residual fouling deposited on external surfaces of weapon components was quite extensive and is normal to the design of the weapon. Figure 1.5-3 shows the feeder mechanism before and after firing 1295 rounds of ammunition during the endurance test.

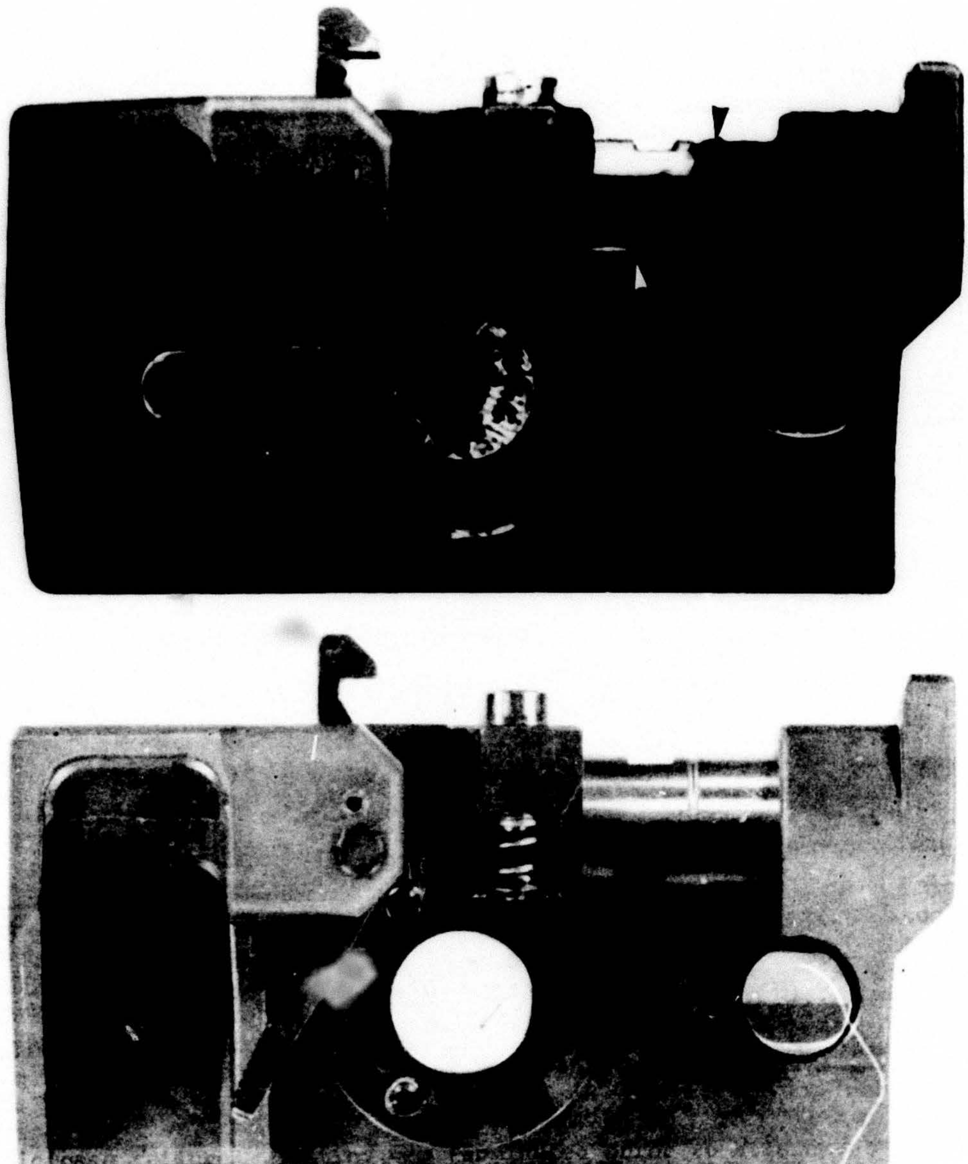

Figure 1.5-3: Residual Fouling Deposits on Rear of Feeder Assembly (Arrows) of the 5.56-MM HK-23A1 Machine Gun (TOP), after 1295 Rounds of Firing. Clean Feeder Assembly Is Shown at Bottom for Comparison.

The maintenance actions performed during evaluation of the HK-23A1 machine gun are presented in Table 1.5-4 (page 50).

Disassembly of the weapon into its major component assemblies (Figure 1.2-5) was found to be simple due to the modular design of the assemblies. Maintenance of the weapon beyond that point was found to require special tools and equipment and to require personnel with a high degree of manual dexterity and mechanical ability to perform detailed disassembly and reassembly. The maintenance publication that was furnished by the contractor's representative specified that the trigger mechanism must not be assembled with the bolt-head carrier in the fully-forward (locked-bolt) position in the receiver, because the retaining pins for the housing would not align properly. These components were assembled in this manner on three occasions during maintenance, with subsequent permanent damage to the weapon. This damage, in the form of deformation of the catch/release lever, rendered the weapon inoperable until a new part was installed. Although the cause was directly attributable to personnel error (maintenance personnel were specifically instructed in the proper method of assembly to insure that this would not occur) it was found that they could readily (and did) incorrectly assemble the weapon. From this experience, it is postulated that the average soldier would also incorrectly assemble his weapon on occasion, while performing field maintenance.

Table 1.5-3. HK-23A1 Machine-Gun Component Part Failures

Subtest Title	Para No.	Component Name	Cumulative Rd Totals Part	Wpn	Action Taken Replaced	Repaired	Remarks
Initial Inspection and Safety Evaluation	1.2	Catch/release lever	0	0	X		Incorrect assembly replaced with spare firing mechanism.
		Catch/release lever	72	72	X		Incorrect assembly. Replaced part.
		Catch/release lever	228	300	X		Same comment as previous failure.
		Firing-pin spring	356	356	-	-	No action taken. End of spring broken.
Endurance	1.4	Hammer	1403	1403	X		Broken. Complete original firing mechanism (containing new catch/release lever) was installed.
		Trigger housing	1403	1403	X		The stop tab for the transport was broken off.
		Locking roller retainer	1403	1403	X		Missing (presumed broken). Replaced with new part from spare bolt head.
		Hammer	997	2400	X		Broken. Replaced with used part from contractor's demonstration weapon (this part also cracked in the same area).
Over-all part failure profile		-	2400	7	0		-

Table 1.5-4. Maintenance Performed during Evaluation of the HK-23A1 Machine Gun (Serial No. 90459)

Maintenance Period		Cumulative	Maintenance		Maintenance Type			
Subtest Title	Para No.	Subtest Rd No.	Action S	Action U	F	O	D	Remarks
					Time, hours			
Initial Inspection and Safety Evaluation	1.2	0	X			2.4		Initial detailed inspection.
		0		X	0.7			Damaged catch/release lever during assembly.
		72	X			0.3		Same remarks.
		80		X		0.3		Same remarks.
		136		X	0.1			Changed barrel and inspected in attempt to clear FBC stoppage.
		136		X	0.1			Removed lodged primer and replaced barrel No. 1.
		280	X		0.1			Cleaned barrel.
Accuracy-Dispersion	1.3	220	X		0.1			Cleaned barrel.
		433	X		0.3			Cleaned weapon.
Endurance	1.4	651		X	0.1			Removed blown primer.
		690		X		0.9		Inspected. Replaced three broken parts.
		837		X	0.1			Removed blown primer.
		918		X	0.2			Removed blown primer.
		1295		X	0.1			Installed spare feeder assembly.
		1315		X	0.2			Removed blown primer.
		1370		X	0.2			Removed blown primer.
		1415		X	0.2			Removed blown primer.
		1482		X	0.1			Installed spare cartridge quide.
		1489		X	0.1			Replaced original cartridge guide.
		1687		X	0.9			Inspected. Replaced broken hammer.
Over-All maintenance profile		2400	5	14	2.7	4.8		Maintenance man-hours per round fired = 31.25×10^{-4}.

Computations of the mean rounds between failure and malfunction rate for each 1000 rounds fired are presented in Table 1.5-5.

Table 1.5-5. Malfunction Rate and MRBF Computation for HK-23A1 Machine Gun

Reference to Subtest Table No.	Total No. Rd Fired	Total No. Chargeable Failures	Point Est for MRBF	Point Est for Malf Rate for Each 1000 Rd Fired
1.2-9	280	6	47	21
1.3-5	433	0	0	0
1.4-4	1687	167	10	99
Over-all	2400	173	14	72

1.5.3 Analysis

The HK-23A1 machine gun tested was unreliable from a functioning performance standpoint, although the majority of all stoppages were readily cleared by the shooter by application of immediate action (i.e., manually recycling the breech components by retracting and releasing the cocking lever).

The increase in cyclic rate noted between the rates recorded at the start of the evaluation and those recorded during the endurance subtest indicates that there was a mechanical change in the weapon of an undetermined nature. A suspect area is in the catch/release lever component because it was the only part changed that bears directly on timing of the firing cycle. Possible incorrect assembly of the firing mechanism was ruled out because a spare firing mechanism, which had not been detail-disassembled, was introduced into the test. Also, the two assemblies were compared to insure that assembly was correct (by inference that the factory-assembled unit was correct). Another possible suspect area is in the fluted chamber. The degree of build-up of residual fouling in these flutes was not measured, or the effects determined.

The large number of parts failures (see Table 1.5-3) are rated as a shortcoming. As noted in paragraph 1.4.3, the causes of some of these failures may be related to the apparent timing problems with the weapon.

1.6 HUMAN-FACTORS EVALUATION

1.6.1 Method

The human-factors data generated during the firing tests (i.e., para 1.2 through 1.4) were collectively presented in this subtest. The data consist of observations on maintenance, safety, and weapon operation.

1.6.2 Results

The need to use slave pins during reassembly of weapon components (i.e., the feeder assembly) is not a desirable design characteristic. It deters "field-expedient" repairs from being accomplished in times of extreme need when spare assemblies or higher echelon maintenance capability is not available.

The markings used to designate compatibility of components used for a specific ammunition/feed mechanism configuration were not self-evident to personnel not possessing a compatibility list (refer to Table 1.2-1). Because the type of ammunition is the controlling factor over the components used, a method of commonality marking such as the cartridge designation (e.g., M193) should be used on all affected parts.

The use of a timing gage was specified in the maintenance literature; however, no remedial action was indicated in the event that the component parts were not found to be within gage limits.

The excessive deposits of propellant combustion residue throughout the weapon mechanism may require frequent maintenance during use in a low-temperature environment, based on performance of other weapon designs exhibiting comparable levels of fouling (not necessarily produced by firing the same number of rounds).

Damage to the catch/release lever (rendering the weapon inoperable), which occurs due to assembly of the firing mechanism to the receiver with the bolt-head carrier in a fully-forward position, must be eliminated by redesign of the weapon. Although this damage will not occur if the weapon is correctly assembled, it has been amply demonstrated that it is likely to occur during scheduled field maintenance even though personnel have been instructed in the proper assembly sequence.

No unusual safety precautions were required to be observed during maintenance of the weapon.

The positions of the selector, charging lever, and magazine latch on the weapon were basically designed for a right-handed shooter, although it can be operated by left-handed personnel without seriously affecting performance. The ejection pattern is to the right and forward of a line perpendicular to the side of the receiver.

Sight settings can be determined either visually or audibly (clicks) throughout the range of the sight. The combat range setting of 300 meters can also be determined by touch.

Because the weapon safety can be applied with the weapon either cocked or uncocked, it provides full-range protection from inadvertent fire due to pulling the trigger. This feature, while desirable, negates the ability to use the safety as a means of determining if the weapon is cocked and potentially ready to fire (by blocking the safety from the ON position until the weapon is cocked).

The generally smooth external profile of this weapon will tend to minimize snagging in thickly vegetated environments.

1.6.3 Analysis

The general design of the HK-23A1 machine gun from a human-factors standpoint is satisfactory. Design changes to improve ease of detailed component assembly and prevent damage to the parts would enhance the over-all serviceability of the weapon.

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